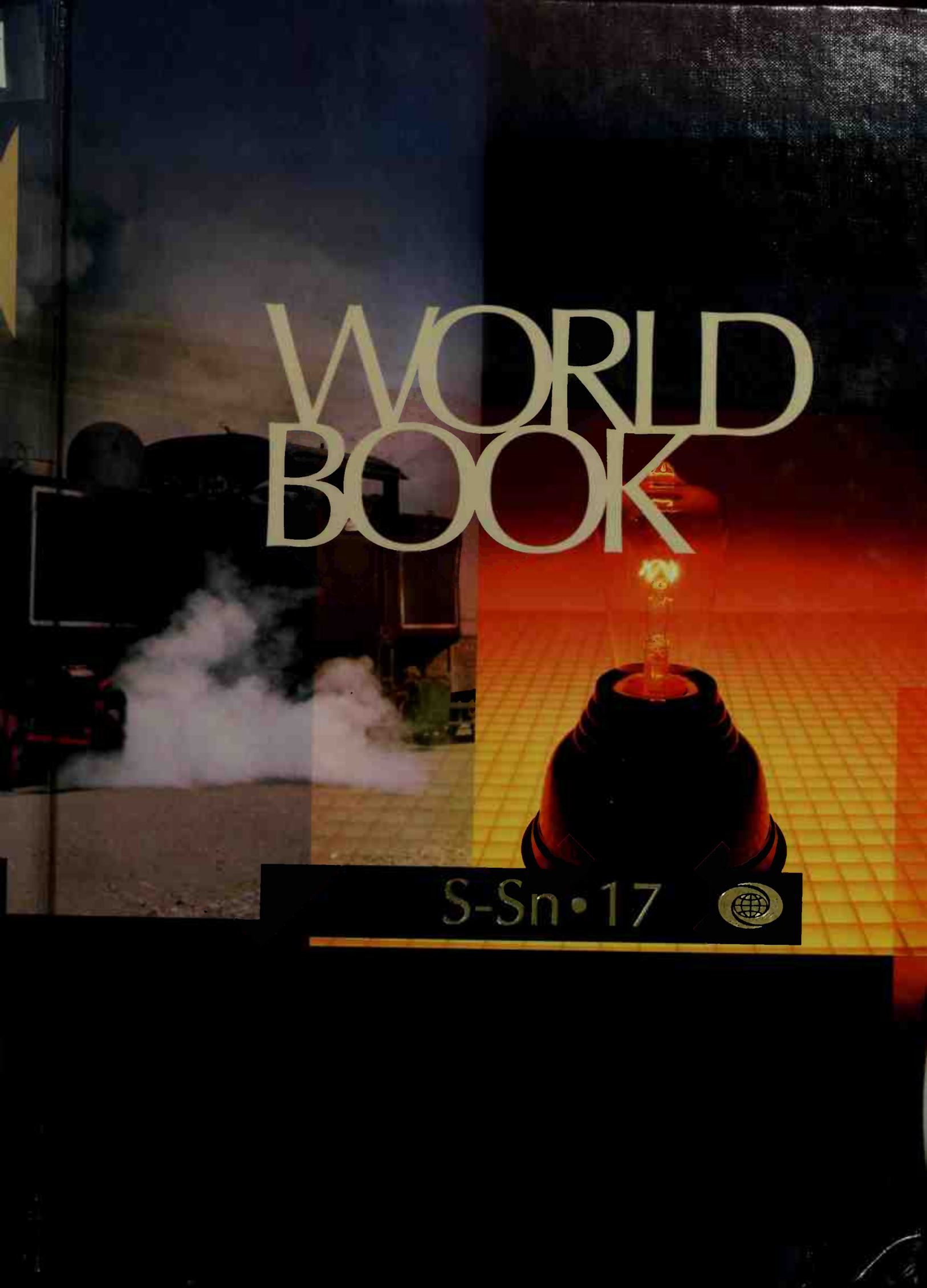
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Ss

S is the 19th letter in our alphabet. It was also a letter in the alphabet of the ancient Semites, who once lived in Syria and Palestine. They called the letter *shin,* meaning *tooth.* The Phoenicians took over the Semitic letter and gave it a more regular shape, and the Greeks turned it on its side. See **Alphabet.**

Uses. *S* or *s* is about the eighth most frequently used letter in books, newspapers, and other printed material in English. When used on a report card, *S* may mean *superior* or *satisfactory.* As a geographic abbreviation, it stands for *south* or *southern.* As an abbreviation in titles, *S* often means *society, state,* or *school.* In music, *s* is used as an abbreviation for *soprano* or *solo.* It stands for the element *sulfur* in chemistry, and for *singular* number in grammar textbooks and in dictionaries. It is also used as an abbreviation for *size* in advertisements and catalogues.

Pronunciation. *S* has two common sounds in English. It can have a hissing sound, as in *sat.* A person produces this sound by forcing the breath through the open lips with the tongue below the lower teethridge and the vocal cords relaxed. *S* can be pronounced as *z* in the middle or at the end of a word (*season, has*). This sound is produced in much the same way, but with the vocal cords vibrating. In such words as *aisle* or *debris,* the *s* is silent. *S* has the same sounds in French, German, and most other European languages that it has in English. See **Pronunciation.**

Marianne Cooley

Development of the letter S

The ancient Egyptians drew this symbol of a tusk about 3000 B.C.

The Semites, about 1500 B.C., developed a letter they called *shin,* which was their word for *tooth.*

W

The Phoenicians squared off the letter about 1000 B.C.

Σ

The Greeks, about 600 B.C., turned the letter on its side and called it *sigma.*

S

The Romans gave the letter S its capital form about A.D. 114.

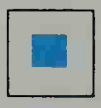
The small letter s developed during the A.D. 500's from Roman writing. By the 1500's, the letter had the form that is used today.

A.D. 500 | 1500 | Today

Special ways of expressing the letter S

International Morse Code

Braille

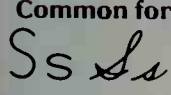


International Flag Code

Semaphore Code

Sign Language Alphabet

Common forms of the letter S



Handwritten letters vary from person to person. *Manuscript* (printed) letters, *left,* have simple curves and straight lines. Cursive letters, *right,* have flowing lines.

Roman letters have small finishing strokes called *serifs* that extend from the main strokes. The type face shown above is Baskerville. The italic form appears at the right.

Ss Ss

Sans-serif letters are also called *gothic letters.* They have no serifs. The type face shown above is called Futura. The italic form of Futura appears at the right.

Computer letters have special shapes. Computers can "read" these letters either optically or by means of the magnetic ink with which the letters may be printed.

Saadi, *sah DEE* (1213?-1292), was a famous Persian author who wrote many works in both prose and poetry. His best-known work is the *Golestan (Rose Garden),* a collection of short prose tales with moralizing verses attached. Saadi's writings are characterized by a clear and modest style, and by their tolerance and humanity. The clarity and high moral quality of his work have made him perhaps the most popular of all Persian writers.

Saadi was born in Shiraz. He lived in politically unstable times and spent much of his life moving from place to place and patron to patron. Dick Davis

Saar, *zahr* or *sahr,* is a state in Germany on the Franco-German border (see Germany [political map]). The Saar covers 994 square miles (2,574 square kilometers) and has 1,073,000 people. It is named after the Saar River, which flows through the area. The region is also called the Saar Territory, or the Saar Basin. The German name for the Saar is *Saarland.* The Saar is valuable for its many coal mines and steel plants. The capital of the Saar is Saarbrücken.

Before World War I (1914-1918), the Saar belonged to Germany. After the war, France wanted to annex the Saar in payment for war damages. The Treaty of Versailles gave France the use of the Saar coal mines for 15 years in payment for French losses. The League of Nations governed the Saar during the French occupation. The governing body included a French citizen, a German, and three people of other nationalities. Germany protested, and in 1930 the League ordered an end to allied control. Most of the region's people were Germans. They voted in 1935 to become part of Germany.

As a result of Germany's defeat in World War II (1939-1945), France occupied the Saar in 1945. Germany was divided into West Germany and East Germany. France directed the Saar's defense and foreign relations and controlled its heavy industries. The Saar also joined in a customs and currency union with France. The Saar was allowed partial self-government in 1947. In October 1955, the people voted against transferring the responsibilities of defense and foreign relations from France to the Western European Union. On Dec. 18, 1955, they elected a parliament pledged to unite the Saar with West Germany. By agreement between France and West Germany, this union occurred on Jan. 1, 1957. West Germany and East Germany united in 1990. John W. Boyer

Saarinen, *SAHR uh NEHN,* **Eero,** *AY roh* (1910-1961), was an American architect noted for his daring use of sculptural form. In 1948, his design of a giant stainless steel arch won a competition for a memorial in St. Louis, Missouri. The arch was completed in 1965. Saarinen gained his greatest recognition for his boxlike steel-frame buildings for the General Motors Technical Center (1945-1956) in Warren, Michigan. His Kresge Auditorium (1953-1956) at the Massachusetts Institute of Technology (MIT) is a reinforced concrete dome with only three points of support. His MIT chapel (1953-1956) is a small brick cylinder. His Trans World Airlines Terminal (1956-1962) at Kennedy International Airport in New York City uses winglike forms of reinforced concrete.

Saarinen was born on Aug. 20, 1910, in Kirkkonummi, Finland, near Helsinki. He moved to the United States in 1923. From 1937 to 1950, he worked with his father, Eliel, who was also a famous architect. Leland M. Roth

For examples of Eero's designs, see Architecture (An airline terminal); Furniture (Classics of modern furniture design); Saint Louis (St. Louis).

Saarinen, *SAHR uh NEHN,* **Eliel,** *EH lyehl* (1873-1950), was a Finnish-born architect. He became internationally famous for the bold and simplified traditional design of his Helsinki railroad station (1904-1914). He also gained recognition for his entry in 1922 in a competition to select a design for the Chicago Tribune Tower.

In 1923, Saarinen settled in the United States. In 1924, he began designing the buildings for what is now the Cranbrook Educational Community, a complex of schools in Bloomfield Hills, Michigan. He was president of the Cranbrook Academy of Art from 1932 to 1946. From 1937 until his death, Saarinen worked with his son, Eero. But Eliel is chiefly credited with two of their finest works—Tabernacle Church of Christ (1939-1942) in Columbus, Indiana, and Christ Lutheran Church (1947-1950) in Minneapolis, Minnesota. Saarinen was born on Aug. 20, 1873, in Rantasalmi, near Varkaus. Leland M. Roth

Sabbath is the seventh day of the week, observed by Jews and some Christians as a day of rest and worship. Most Christians call Sunday the Sabbath. In Biblical times, the Sabbath was a joyous, holy day. People stopped working, went to Temple, and gave extra sacrifices. One of the Ten Commandments (Exod. 20: 8-11) requires resting on the Sabbath.

Jews took observance of the Sabbath seriously. They suffered many losses and insults rather than break the Sabbath laws. In the Oral Law, 39 kinds of labor were forbidden. These included the procedures related to growing, preparing, and cooking food; weaving and making clothes; slaughtering animals and preparing hides; writing; building; carrying things from one location to another; and lighting fires.

Many Jews still keep strict Sabbath regulations. Their Sabbath lasts from sunset Friday evening until nightfall Saturday, at the time when it is calculated that three stars could be seen in the evening sky. Most Christians observe Sunday as the Sabbath because they believe Jesus Christ rose from the dead on Sunday (see **Sunday**). The Seventh-day Adventists, a Christian denomination, observe Saturday as the Sabbath. B. Barry Levy

Saber-toothed cat, also called *saber-toothed tiger,* was a catlike prehistoric animal. It was one of many catlike species that had enlarged *canine teeth* (long, pointed teeth near the front of the mouth). The teeth were shaped like *sabers* (curved swords), and were about 8 inches (20 centimeters) long. The first saber-

Painting by Charles R. Knight, © American Museum of Natural History

The saber-toothed cat, a prehistoric animal, had two long, fanglike teeth that helped it catch and eat its prey.

toothed cats lived about 40 million years ago. They became extinct about 10,000 years ago. Fossils have been found in Africa, Europe, and North and South America. The cats were probably as heavy as today's tigers. They probably ate thick-skinned animals, including elephants, mastodons, and ground sloths. Michael R. Voorhies

Scientific classification. Some species of saber-toothed cats belong to the cat family, Felidae. Others belong to Nimravidae, an extinct family. The scientific name for the best-known American species is *Smilodon californicus.*

Sabin, *SAY bihn,* **Albert Bruce** (1906-1993), an American medical researcher, developed the oral polio vaccine. The Sabin vaccine consists of weakened forms of the viruses that cause polio. It protects the body against polio without causing the disease, except in extremely rare cases. See **Poliomyelitis.**

Sabin developed the vaccine in the late 1950's, and physicians in the United States began to use it in 1961. The earlier vaccine against polio, developed by the American research scientist Jonas E. Salk in 1954, had to be given by injection. The Sabin vaccine is easier to give, and its effects last longer. The widespread use of both types of vaccines has nearly eliminated polio in many regions of the world. Sabin also developed vaccines against other virus diseases, including encephalitis and dengue. In addition, he investigated possible links between viruses and some forms of cancer.

Sabin was born Aug. 26, 1906, in Bialystok, Poland. His family settled in the United States in 1921. He graduated from the New York University College of Medicine in 1931. Sabin served on the staffs of many medical institutions, including the University of Cincinnati College of Medicine and the Medical University of South Carolina. His research won him many awards. Daniel J. Kevles

Sabin, Florence Rena, *SAY bihn, FLAWR ehns REE nuh* (1871-1953), an American scientist, did important research in human embryology. Sabin showed that blood cells and the lymphatic system develop from buds on the veins of an embryo.

Sabin was born Nov. 9, 1871, in Central City, Colorado. She graduated from Johns Hopkins Medical School in 1900 and taught there until 1925. That year, she became the first woman elected to the National Academy of Sciences. From 1925 to 1938, she worked at the Rockefeller Institute for Medical Research (now Rockefeller University). After retirement, Sabin worked for public health reform in Colorado. Her statue represents Colorado in the United States Capitol's Statuary Hall. Daniel J. Kevles

Sabines *SAY bynz,* were a people who lived in ancient Italy. They lived northeast of Rome and were related to the Romans. The Sabines are famous for a legend told about them. According to the legend, no women lived in Rome when Romulus founded the city. Romulus asked nearby cities to allow Romans to choose wives from among their women. When the cities refused, Romulus invited all the surrounding people to attend a great festival. During the festival games, the Romans carried off young Sabine women by force. The Sabines went to war with the Romans, but the women persuaded the two tribes to stop fighting and unite as one nation. Herbert M. Howe

Sable, *SAY buhl,* is a small animal in the weasel family. It has the most valuable pelt of all weasels. Sables range from eastern Russia across Siberia and Mongolia to Hokkaido, in northern Japan. They are closely related to North American *pine martens,* also called *American sables* (see **Marten**). The sable is about 20 inches (51 centimeters) long, including its 5-inch (13-centimeter) tail. Its fur ranges from dark brown to almost black, with a grayish-yellow patch on the throat. Its coat does not change to white in winter, as do those of some animals. Furriers make it into expensive clothing (see **Fur**).

WORLD BOOK illustration by John D. Dawson

The sable is a rare animal that is native to Siberia. Sables are bred and raised on sable farms for their luxurious fur.

Due to the demand for the fur, trappers have killed off sables in the western and southwestern Russian range. Sables are rare almost everywhere. The Russian government has closed the trapping season several times and has developed successful methods of raising sables.

Gary A. Heidt

Scientific classification. The sable belongs to the family Mustelidae. It is *Martes zibellina.*

Sable Island is a small island in the Atlantic Ocean, about 100 miles (160 kilometers) southeast of the coast of Nova Scotia. It lies near the North Atlantic shipping lane between North America and Europe. The island is a dangerous hazard to navigation. It has been the site of many shipwrecks. Thus, sailors have called it the *graveyard of the Atlantic.* Today, radar and other aids prevent most accidents.

WORLD BOOK map

Location of Sable Island

Sable Island is about 24 miles (38 kilometers) long and 1 mile (1.6 kilometers) wide. It consists of low sand dunes and is surrounded by *shoals* (sand bars). The name *Sable* derives from a French word meaning *sand.* The island's size and shape are constantly changed by wind and water erosion. Sable Island is partly covered by grass and scrub, and so it supports many birds and ocean mammals. It is also the home of a herd of wild horses. The animals are descendants of horses brought by people who failed in an attempted settlement in the 1700's. Today, the only people on the island work for a weather station. Deposits of oil and natural gas have been found in shallow waters around the island. Oil production began in 1992.

D. A. Sutherland

Sabotage, *SAB uh tahzh,* is any means of deliberately wasting or damaging the tools, machinery, or produc-

tion of an employer or government. The word originated in the 1800's when French workers would throw their *sabots* (wooden shoes) into machines to halt production. In Spain, France, and Italy, sabotage was used by the *syndicalists,* members of anarchist trade unions.

In wartime, sabotage by trained agents called *saboteurs* is a means of damaging war production and communications in enemy countries. Since World War II ended in 1945, a number of countries have used sabotage in *covert* (secret) wars to intimidate or overthrow other governments. Edwin B. Firmage

See also **Fifth column.**

Sac Indians. See Sauk Indians.

Sacagawea, *sah KAH guh WEE uh* (1787?-1812), was a Shoshone Indian woman who accompanied the Lewis and Clark expedition in 1805 and 1806. The expedition, an early exploration of the Northwestern United States, was led by U.S. Army officers Meriwether Lewis and William Clark. Sacagawea has often been depicted in art and literature as the expedition's heroic guide. But in reality, her contributions, though important, were much more limited. Sacagawea's name means *Bird Woman.* It is also spelled *Sacajawea* (pronounced *SAK uh juh WEE uh*) or *Sakakawea* (*sah KAH kah WEE uh*).

Sacagawea joined the expedition in what is now North Dakota, after Lewis and Clark had hired her husband as an interpreter during the winter of 1804-1805. Sacagawea's husband was a French-Canadian trader named Toussaint Charbonneau. Lewis and Clark thought Sacagawea might be helpful when the expedition reached Shoshone territory in the Rocky Mountains.

In the Rockies in August 1805, the explorers met a band of Shoshone Indians whose chief was Sacagawea's brother. Sacagawea aided in communication between the Shoshone and the explorers. She also helped secure horses from the tribe for the explorers. A number of geographic landmarks, monuments, and memorials have been named for her. In addition, a U.S. dollar coin commemorating Sacagawea went into circulation in early 2000. Gary E. Moulton

Bettmann Archive

Sacagawea has often been depicted in art and fiction as the heroic guide of the Lewis and Clark expedition. But her actual role—partly that of an interpreter—was much more limited.

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Saccharides, *SAK uh rydz,* are carbohydrates—one of the three main classes of food. Fats and proteins form the other two classes. Saccharides are classified according to their chemical structure. *Monosaccharides,* which have the simplest structure, include *glucose,* a sugar found in the blood. Monosaccharides, unlike other saccharides, cannot be broken down into simpler carbohydrates by treatment with dilute acids or by the action of certain enzymes. *Disaccharides,* such as *sucrose* (table sugar), consist of two monosaccharide molecules linked by an oxygen atom. *Polysaccharides,* such as starch and cellulose, may consist of thousands of linked monosaccharides. For a diagram of saccharide molecules, see **Carbohydrate.** See also **Starch.** Dorothy M. Feigl

Saccharin, *SAK uhr ihn,* is a synthetic sweetener. It is made from toluene and petroleum. It is about 300 times as sweet as table sugar but has no carbohydrates and no food value. Saccharin also has a bitter aftertaste.

Saccharin has been widely used in place of sugar by people dieting to lose weight and by people with diabetes. It is made in the form of tiny tablets or as a powder or a liquid. Manufacturers use saccharin in such products as low-calorie soft drinks, sugarless chewing gum, jams, jellies, puddings, and salad dressings. In 1977, the U.S. Food and Drug Administration (FDA) moved to ban the use of saccharin in prepared foods, after tests indicated that it could cause bladder cancer in male rats. But the U.S. Congress blocked this move. In 1981, the National Toxicology Program (NTP), a part of the U.S. Department of Health and Human Services, added saccharin to its list of known human *carcinogens* (substances that can cause cancer). But in 2000, the NTP removed saccharin from the list, saying that the link to bladder cancer does not apply to human beings. Canada banned the use of saccharin in foods in 1977. But more than 80 other countries approve its use.

Saccharin was discovered in 1879 by Constantin Fahlberg, a chemist at Johns Hopkins University. It has been sold commercially since about 1900. Its chemical formula is $C_6H_4SO_2NHCO$. Jane Ann Raymond Bowers

See also **Artificial sweetener.**

Sacco-Vanzetti case, *SAK oh van ZEHT ee,* was a controversial murder trial held in Massachusetts in 1921. The defendants were two Italian immigrants, Nicola Sacco, a shoemaker, and Bartolomeo Vanzetti, a fish peddler. They were both executed.

The case, which attracted worldwide attention, began after two custodians of a shoe company payroll were robbed and murdered in South Braintree, Massachusetts, in 1920. Sacco and Vanzetti were arrested and charged with the crime. Both were carrying guns when they were arrested, and Sacco's pistol was of the same caliber as that used to kill one of the murder victims. Both defendants also supported a political philosophy known as *anarchism,* which called for the overthrow of all systems of government (see **Anarchism**). Sacco and

Vanzetti were convicted and sentenced to die. After passing sentence, Judge Webster Thayer indicated that he shared the views of many people who assumed the pair's guilt because they were anarchists.

But many other people believed there was too little evidence to prove Sacco and Vanzetti were guilty. Their supporters also argued that Sacco and Vanzetti had been convicted mainly because they approved of anarchism. Appeals and other legal reviews lasted six years. Sacco and Vanzetti were executed in August 1927. Widespread public protest followed the execution.

Today, many historians believe that Sacco may have been guilty, and that Vanzetti was probably innocent. But in either event, it is thought that the evidence was insufficient to support conviction. In 1977, Governor Michael Dukakis of Massachusetts signed a proclamation that recognized the faults of the trial and cleared the names of Sacco and Vanzetti. James D. Forman

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Sachs, *zahks,* **Nelly** (1891-1970), was a German-born Jewish poet and dramatist. She shared the 1966 Nobel Prize for literature with the Israeli writer Shmuel Yosef Agnon. The Nobel judges honored Sachs's "outstanding lyrical and dramatic writing, which interprets Israel's destiny with touching strength." Most of her poetry deals with persecution and agonies endured by the Jewish people for hundreds of years.

Sachs was born and educated in Berlin. Her first published work was *Legends and Tales* (1921), a collection of short stories. In 1940, during World War II, she fled to Sweden to avoid persecution of Jews by the Nazis in Germany. After World War II, Sachs wrote poetry about the Holocaust—the mass murder of European Jews and others by the Nazis. Sachs wrote in German. English translations of many of her poems are contained in *O the Chimneys* (1967) and *The Seeker and Other Poems* (1970). Her best-known play is *Eli: A Mystery Play of the Sufferings of Israel* (1950). Werner Hoffmeister

Sackville-West, Victoria Mary (1892-1962), was an English writer whose books reflect her aristocratic, country family background. Her best-known novel, *The Edwardians* (1930), examines English upper-class life during the reign of Edward VII in the early 1900's. Set against a background of country estates, the book captures the social and emotional flavor of that time.

Victoria Sackville-West also wrote more powerfully of the family in the novels *All Passion Spent* (1931) and *The Dark Island* (1934). She dealt with country living in the nonfiction books *Country Notes* (1939), *English Country Houses* (1941), and *In Your Gardens* (1951); and in many of her poems. Her poem *The Land* (1929) is a modern classic.

Victoria Sackville-West was born in Knole Castle, a country house that was given to her ancestors by Queen Elizabeth I. She traveled widely with her husband, the diplomat and author Sir Harold Nicolson. Nigel Nicolson, their son, described their marriage in *Portrait of a Marriage* (1973). Jane Marcus

Sacrament, *SAK ruh muhnt,* in Christianity, is a solemn observance. It is an outward sign that a faithful worshiper is receiving the grace of God. The various Christian churches recognize different numbers of sacraments. The Roman Catholic and Eastern Orthodox churches have seven sacraments—baptism, confirmation, Eucharist, penance (also called *confession*), anointing of the sick, holy orders, and matrimony. Most Protestant churches recognize two sacraments—baptism and Communion (also called the Lord's Supper). Quakers do not observe outward forms but consider all life a sacrament. Roman Catholics believe that sacraments aid salvation. Although Protestants observe sacraments in worship services involving many people, most Protestants see sacraments as signs of agreement between God and individuals. Frank C. Senn

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Baptism
Communion
Confirmation
Eastern Orthodox Churches (Sacraments)
Marriage
Protestantism (Belief in sacraments)
Roman Catholic Church (Worship)

Sacramento, *SAK ruh MEHN toh* (pop. 407,018; met. area pop. 1,628,197), is the capital of California and the commercial center of a rich farming region. It lies at the junction of the Sacramento and American rivers in California's Sacramento Valley, about 85 miles (137 kilometers) northeast of San Francisco. For location, see **California** (political map).

Sacramento is a historic city of the American West. It was founded as a town in 1849 by John A. Sutter, Jr., who was the son of the Swiss pioneer who established the first European settlement in the area. Sacramento became a mining center during the California gold rush of 1849. Construction of the Central Pacific Railroad, a link in the first railway to cross the United States, began in Sacramento in 1863.

The city. Sacramento, the seat of Sacramento County, covers 95 square miles (246 square kilometers) in north-central California. Its metropolitan area spreads over three counties—El Dorado, Placer, and Sacramento. The city's metropolitan area and the Yolo metropolitan area form the Sacramento-Yolo consolidated metropolitan area (pop. 1,796,857).

The state Capitol stands in Capitol Park, which occupies 40 acres (16 hectares) in the heart of Sacramento (see **California** [picture: State capitol]). The city originally lay along the east bank of the Sacramento River. Many of the structures that were built along the east bank during the mid-1800's have been restored. The area is called Old Sacramento.

Economy. Federal and state government agencies employ many of the workers in Sacramento's metropolitan area. A number of telephone customer-service centers in the area employ thousands of people.

Sacramento has hundreds of manufacturing plants. Food processing and high technology activities rank as leading industries in the area. Fruit and vegetable canneries in the Sacramento area process and pack products of California's agricultural regions. The California Almond Growers Exchange, in the city, is California's largest almond processing plant. Sacramento's other

products include boxes, computer chips, computer terminals, fertilizer, and soup.

A deepwater channel, completed in 1963, links the Port of Sacramento to San Francisco Bay and the Pacific Ocean. The port serves oceangoing ships, which pick up rice and other exports of the Sacramento Valley. Railroad passenger trains, two rail freight lines, and four major highways serve Sacramento.

Sacramento International Airport lies northwest of the city. Sacramento Executive Airport, located in the heart of the city, serves business and private aircraft.

Education and cultural life. The city's public school system has about 80 elementary schools and 7 high schools. There are also over 20 church-supported schools. Sacramento is the home of the McGeorge School of Law of the University of the Pacific and California State University at Sacramento. The University of California has a branch campus in nearby Davis.

The E. B. Crocker Art Museum, the oldest art museum in the western United States, opened in Sacramento in 1885. It houses many paintings by European masters. The Old Sacramento area features the California State Historic Railroad Museum and the reconstructed Central Pacific Passenger Station. There, visitors can see railroad cars from the past. A fort that was built in 1839 by the pioneer settler John A. Sutter has been restored in east-central Sacramento.

Cultural groups sponsor ballet, opera, symphony orchestra, and theater programs. The California State Fair is held in Sacramento every August and September. The city has 80 parks. William Land Park, the largest, covers 236 acres (96 hectares). It includes a golf course and a zoo. The city is the home of the Sacramento Kings of the National Basketball Association. Sacramento has a daily newspaper, *The Sacramento Bee*.

Government. Sacramento has a council-manager form of government. The people elect a mayor and eight other members of the city council to four-year terms. The council hires a city manager to serve as the administrative head of the city government. Property taxes provide about one-third of Sacramento's income. Utility and sales taxes are other important revenue sources for the city.

History. In 1839, a group of settlers led by John A. Sutter, a Swiss pioneer, established a colony along the American River. The colony lay about 2 miles (3.2 kilometers) east of the Sacramento River. It was the first European settlement in inland California, then controlled by Mexico. Sutter received about 50,000 acres (20,000 hectares) of land in the area by pledging loyalty to Mexico. In the 1840's, his fort was the western terminal for wagon trains of pioneers.

In 1848, the discovery of gold at Sutter's sawmill drew thousands of fortune seekers to the area. The next year, Sutter's son, John A. Sutter, Jr., founded the town of Sacramento along the east bank of the Sacramento River. The town was named for the river. During the gold rush of 1849, Sacramento became a center of mining activities, and its population soon rose to 10,000. Sacramento was incorporated as a city in 1850 and became the state capital in 1854.

The first railroad in the West was built during the 1850's to connect Sacramento and Folsom, California. In 1860 and 1861, riders of the pony express carried the U.S. mail between Sacramento and St. Joseph, Missouri (see Pony express). In 1863, construction of the Central Pacific Railroad, the first railway to cross the Sierra Nevada, began in Sacramento. In 1869, the Central Pacific connected with the Union Pacific at Promontory, Utah, and became part of the first coast-to-coast link in the United States.

During the late 1800's, farmers started to grow cotton, fruits, and vegetables in the Sacramento Valley. Sacramento became an important trading center for these crops. Between 1870 and 1900, the city's population increased from 16,283 to 29,282. Agriculture in the Sacramento area continued to develop rapidly in the early 1900's, and canning and food processing became Sacramento's chief manufacturing activities. By 1930, the city's population had climbed to 93,750.

After World War II ended in 1945, many new industries, including rocket engine production, began in Sacramento. The city started to annex large areas of nearby vacant land during the 1950's. Between 1950 and 1960, the area of Sacramento increased from 17 square miles (44 square kilometers) to about 43 square miles (111 square kilometers). During this same period, the population of Sacramento increased from 137,572 to 191,667.

In the 1950's and 1960's, a number of large shopping centers opened in the suburbs of Sacramento and took retail trade away from the city's merchants. Much of Sacramento's downtown area was rebuilt during the 1960's and 1970's. A number of decaying buildings were torn down, and modern stores, banks, and office buildings replaced them. The historic Old Sacramento area was reconstructed. A mass transit rail line was completed in 1987.

During the 1990's, the convention center and the marina were greatly expanded. The remodeled Downtown Plaza opened. The historic Sacramento Memorial Auditorium, originally built in 1926, was refurbished.

Peter Basofin

Sacramento River, *sak ruh MEHN toh,* is the longest river in California. It drains the fertile Sacramento Valley in the northern part of the Central Valley of California. The river rises near the slope of Mount Shasta and flows south into a delta, where it joins the San Joaquin River. Both rivers empty into San Francisco Bay. For the location of the Sacramento River, see California (physical map). The Sacramento River is 382 miles (615 kilometers) long.

The Sacramento receives many important tributaries from the Sierra Nevada. Feather River is the main eastern tributary. Oroville Dam extends across Feather River. The dam is a major part of the State Water Project, which supplies irrigation water to central and southern California.

Shasta Dam is located on the Sacramento River. The dam is part of the Central Valley Project. See Shasta Dam.

Roger Barnett

Sacrifice is a religious ceremony in which something is given to a god or the gods, thus becoming "holy." The word comes from two Latin terms meaning *to make holy.* People offering the sacrifice often expect to receive some physical or spiritual good, and to achieve a proper relationship with the sacred power. Sacrifices have included food, animals, and even human beings.

There are many theories about the origin of sacrifice. Some people claim that it was divinely instituted. Others believe it developed from people's inner conflicts, uncertainties, or feelings of guilt and remorse. Still others believe the sacrificed object occupies a middle space between humanity and sacred beings, thus connecting them.

Many religions include a ritual of sacrifice, often symbolically. Orthodox Christianity teaches that the sacrifice of Jesus makes other sacrifices unnecessary. The Jews have not used sacrifice since A.D. 70, when the Temple in Jerusalem was destroyed. Some religions, such as Buddhism, oppose sacrifice. Jonathan Z. Smith

See also **Altar; Aztec** (Religion); **`Id al-Adha; Mythology** (American Indian mythology).

Sadat, *suh DAHT,* **Anwar el-,** *AHN wahr ehl* (1918-1981), was president of Egypt from 1970 until his death in 1981. Under his leadership, Egypt negotiated with Israel to end the longstanding conflict between the two countries. Although Sadat gained widespread admiration for his peacemaking efforts, other Arab leaders severely criticized him for negotiating independently. Sadat was assassinated in Cairo on Oct. 6, 1981, by a group of Egyptian religious militants who opposed his policies.

Sadat became president in 1970 after the death of President Gamal Abdel Nasser. Like Nasser, Sadat demanded the return of Egypt's Sinai Peninsula and Gaza Strip, which Israel had occupied after the Arab-Israeli War of 1967. In the 1970's, Sadat's government reached agreements with Israel under which Israeli troops withdrew from parts of the Sinai. In 1977, Sadat and Israeli Prime Minister Menachem Begin started discussions of ways to end the Arab-Israeli conflict. In 1978, Sadat, Begin, and United States President Jimmy Carter held discussions at meetings arranged by Carter. The discussions resulted in a major agreement that included plans for Israel's withdrawal from all of the Sinai. The agreement also called for the creation of a peace treaty between Egypt and Israel. The peace treaty was signed in 1979, and Israel completed its withdrawal from the Sinai in 1982. The treaty also called for self-government for the Gaza Strip and the Israeli-occupied West Bank of Jordan. Sadat and Begin shared the 1978 Nobel Peace Prize for their efforts to end the Arab-Israeli conflict. But no arrangements for self-government in Gaza and the West Bank were made at that time. For information on later developments regarding the West Bank and Gaza, see **Middle East** (Recent developments).

Sadat was born on Dec. 25, 1918, in a village in the Nile River Delta. He graduated from the Egyptian Military Academy in 1938. He then joined Nasser and other young military officers in a secret group that worked to overthrow the government and rid Egypt of British influence. Sadat was imprisoned in the 1940's for his revolutionary activities. In 1952, he helped lead the revolt that overthrew King Faruk. Sadat held a series of important government positions after the uprising. He was vice president of Egypt from 1964 to 1967 and from 1969 to 1970. Frank Tachau

See also **Egypt** (Renewed warfare and peace); **Arab-Israeli conflict.**

Additional resources

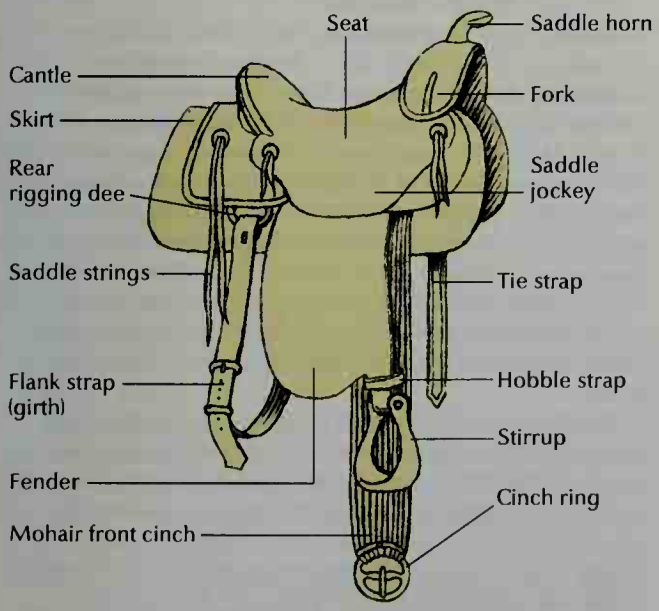
Beattie, Kirk J. *Egypt During the Sadat Years.* Palgrave, 2000.
Finklestone, Joseph. *Anwar Sadat.* Frank Cass, 1996.

Saddle is a seat used by a rider on a horse. There are many different kinds of saddles. They range from a mere blanket, such as American Indians used, to the saddles of feudal knights, which supported them on their horses when they were struck with a lance or spear.

The main parts of most saddles are a *seat,* usually made of leather; a *girth* (strap) underneath the horse, which may be tightened to secure the saddle; and *stirrups* for the rider's feet. There is usually a *pad* under the seat to protect the horse's back from irritation, and a leather *flap,* which hangs down on both sides of the horse to protect its sides.

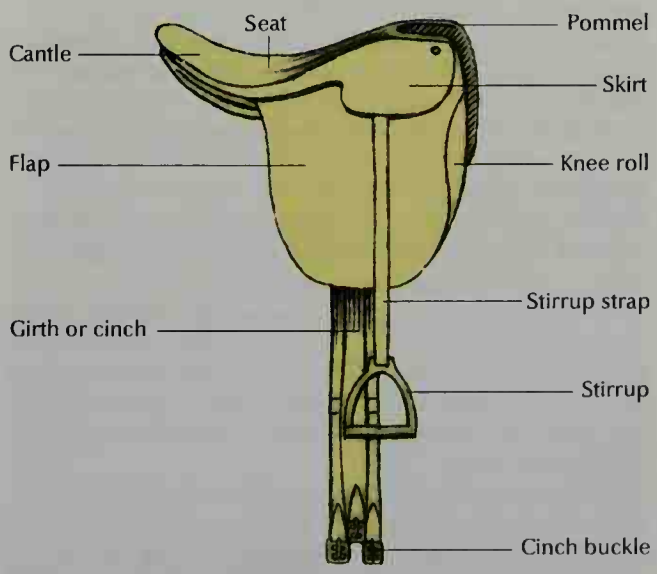
The two most common saddles in America are the *English* and the *Western.* The English saddle is almost flat, with only a slight curve in the seat. The front of the

Western saddle



WORLD BOOK illustration by James Teason

English saddle



WORLD BOOK illustration by James Teason

seat comes to a slight point called the *pommel,* while the back is wider and slightly raised to form the *cantle.* The Western saddle has wide stirrups, a high cantle, and a pommel raised to make a *horn* to which a lariat may be fastened. James H. Blackwell

See also Horse (Riding equipment).

Sadducees, *SAD yoo seez,* were members of a religious group of Jews that was active in Judea, in Palestine, until A.D. 70. The Sadducees gained influence in Judea after Judea became part of the Roman Empire in 63 B.C. They opposed a group of Jews called the Pharisees in religious beliefs and practices. Unlike the Pharisees, the Sadducees accepted only the written law of the Hebrew Bible, and refused to recognize the Oral Law as binding upon them. In addition, the Sadducees did not believe in immortality, as the Pharisees did. They said that the soul died with the body. In addition, the Sadducees believed that all people had free will and were responsible for whatever good or evil befell them. See also Pharisees; Sanhedrin. Gary G. Porton

Sade, *sahd,* **Marquis de** (1740-1814), was a controversial French novelist and essayist. His works were considered so obscene that many of them remained unpublished until the mid-1900's. Today, some people regard Sade as having been insane and his works as offensive. Many others regard him as an often brilliant writer who defied moral conventions.

Donatien Alphonse François Sade was born on June 2, 1740, in Paris. He served as a cavalry officer in the Seven Years' War (1756-1763). During his 20's, Sade began to show signs of being mentally disturbed. He became involved in many scandals over his acts of cruelty and his sexual behavior. Sade spent most of the years from 1768 to 1803 in prison for his writings and his actions. He was placed in an asylum in 1803 and died there.

Sade produced many essays, plays, and short stories, as well as novels. His best-known novels include *Justine, or the Misfortunes of Virtue* (1791) and *Philosophy in the Bedroom* (1795). His *120 Days of Sodom* was not published until 1904.

In his writings, Sade tried to show that criminal acts and sexual abnormalities are natural to human behavior. The word *sadism* comes from his name. Sadism is the enjoyment of cruelty, especially—as in the case of Sade—for sexual arousal. The unconventional aspects of Sade's writings influenced writers of the surrealism movement of the early 1900's. His works are often used to illustrate certain theories of abnormal psychology.

Carol L. Sherman

Sadi. See Saadi.

Safari, *suh FAR ee,* is an organized trip to hunt or photograph wild animals, usually in Africa. Most safaris last 10 to 21 days. People go on an African safari to hunt one or two of the "big five" game animals, plus several of the African antelopes. The "big five" are Cape buffaloes, elephants, lions, leopards, and rhinoceroses. Rhino hunting is limited to white rhinos in South Africa. Safari outfitters usually lease hunting areas called *concessions,* and have permanent camps.

Most African countries use money collected from hunters to restock game and protect habitats. Most countries also specify the caliber of rifle that may be used to kill the game. All countries limit the number and kind of animals that may be killed. Most countries require professional hunters and safari outfitters to pass tests and obtain licenses. William R. Quimby

Safavid dynasty, *sa FAH veed,* was a family that ruled an influential empire in Southwest Asia from 1501 to 1722. At the height of their power, the Safavids controlled all or parts of present-day Iran, Iraq, Azerbaijan, Turkmenistan, and Afghanistan. The Safavids introduced the Shiah division of Islam to this area and made it the empire's official religion. Today, Shiah Islam is the state religion of Iran, and nearly all Iranians are Shiites.

The name *Safavid* comes from Sheik Safi al-Din, who formed a *mystical* religious order in the 1300's. Mysticism is the belief that God or truth can be known by individual insight rather than by reasoning or study. In 1501, Ismail, a descendant of Safi, became head of the order. Ismail declared himself *shah* (king) and claimed to be a divine *messiah* (savior). His disciples were Turkic warriors known as Qizilbash (Red Heads). The Qizilbash wore red hats to show their Shiite beliefs. In 1501, Ismail and the Qizilbash conquered Persia (now Iran). This conquest marked the beginning of the Safavid empire.

For the next 13 years, Ismail continued to expand his empire. In 1507, he began attacking territory of his western neighbor, the Ottoman Empire. Tension between the Ottomans and Safavids grew. In 1514, the Ottomans turned back the Safavids at Chaldiran, a town in what is now Turkey. Following this defeat, Ismail withdrew from public life and never again led an army into battle.

After Ismail's death in 1524, the two greatest Safavid shahs were Tahmasb (also spelled Tahmasp) and Abbas I. Tahmasb, Ismail's son, ruled from 1524 to 1576, and Abbas I ruled from 1588 to 1629. Art, architecture, and literature flourished under both shahs. Under Abbas, the Persian city of Isfahan was turned into a magnificent capital with beautiful mosques, palaces, and gardens.

The height of the Safavid dynasty's power came under Abbas I. During Abbas's reign, the Safavids helped keep the Portuguese and Spanish from expanding into Islamic areas. But the empire started to decline after the death of Abbas in 1629. The dynasty ended in 1722, when a group of Afghan invaders from the east conquered the Safavids. Kathryn Babayan

See also Abbas I; Isfahan.

Safdie, *SAHF dee,* **Moshe,** *MOY shuh* (1938-), is a Canadian architect and urban designer. He is best known for the high-density housing project called Habitat that he designed for the Expo 67 international exhibition in Montreal. Habitat was composed of prefabricated cubes, identical in size, which were combined in various groupings to create 15 different house types for a unified complex of 158 apartments. These connected apartments became small urban villages in which each unit retained its individuality and privacy. Improved, low-cost versions of Safdie's Habitat have been built in Israel, New York City, Puerto Rico, and the Virgin Islands.

Safdie was born on July 14, 1938, in Haifa, Israel. He became a Canadian citizen in 1959 while studying architecture at McGill University in Montreal. Habitat was partly inspired by the villages Safdie observed in the Middle East. Among Safdie's other commissions is his highly praised design for the National Gallery of Canada in Ottawa, which opened in 1988. Dennis Domer

See also National Gallery of Canada (picture).

Paul Robert Perry

David R. Frazier

© Ellis Herwig from Marilyn Gartman

Taking precautions helps prevent accidents. For example, keep stairways clear of objects. They might cause someone to trip. The worker shown here wears protective clothing while handling chemical drums. Many schools teach safety education.

Safety

Safety is freedom from harm or the danger of harm. The word *safety* also refers to the precautions people take to prevent accidents.

Accidents rank as a leading cause of death throughout the world. In the United States, over 90,000 people die every year as a result of accidents. More than 19 million people are seriously injured. In Canada, about 8,500 people die annually as a result of accidents. Accidents also cost billions of dollars annually in medical expenses and lost income.

Experts called *safety engineers* work in the field of accident prevention. They design structures and equipment to make homes, schools, jobs, highways, and communities safer.

Nevertheless, safety starts with you. Living safely does not mean a dull existence. You can live an active, accident-free life that is full of fun and achievement. But you must be aware of possible hazards and take sensible precautions. Most mishaps can be prevented by following basic safety rules at home, at school, in recreation, on the job, in transportation, and in public places.

Charles C. Vance, the contributor of this article, is Director of Public Relations of the National Safety Council.

Safety at home

Most people consider their home a safe place, but it may be the most dangerous place of all. About one-third of all accidental injuries occur in the home. Household mishaps rank second only to highway accidents as a cause of accidental death in the United States.

With planning, your home can be safe and comfortable. Nearly all accidents that occur in the home can be prevented by following basic safety rules in the kitchen,

Where accidents happen in the United States

Location	Accidental deaths	Disabling injuries*
Roads and highways	41,200	2,200,000
Homes	28,200	6,800,000
Public places	20,000	6,700,000
Workplaces	5,100	3,800,000
Total	92,200	19,400,000

*Injuries that disable a person for at least one day longer than the day of the accident. Figures are for 1998. Individual categories do not add up to total because some deaths and injuries are included in more than one class.
Source: National Safety Council.

Chief causes of accidental deaths in the United States

Types of accidents	Number of deaths
Motor vehicle	41,200
Falls	16,600
Poisoning by solids and liquids	8,400
Drowning	4,100
Fires	3,700
Choking	3,200
Firearms	900
Poisoning by gases and vapors	600
All other types	13,500
Total	92,200

Figures are for 1998.
Source: National Safety Council.

in the bathroom, in utility areas, and in the yard. In addition, you must take precautions for safety with electricity and for protection against fire.

In the kitchen. In many homes, the kitchen is the busiest room—and one of the most dangerous. Climbing and reaching cause many accidents in the kitchen. Never use a chair, table, or pile of boxes as a ladder. Use a real ladder and have someone hold it for you if possible. Do not lean to the side while on the ladder. Careful storage reduces awkward climbing and reaching. For example, keep heavy objects, such as food mixers and roasting pans, on low shelves, and light items higher up.

To prevent cuts, keep kitchen knives in a knife rack, not loose in a drawer. Store sharp-edged tools in a rack or box. Sweep up broken glass as soon as possible, and never pick up glass splinters with your bare hands. Sweep the splinters into a dustpan and use a damp paper towel to pick up any remaining particles.

Prevent falls by wiping up water, grease, or anything else spilled on the floor. If you use floor wax, buff the waxed surface thoroughly or use a nonskid product to make the floor less slippery.

Be careful not to burn or scald yourself or others while cooking. Turn pot handles toward the back of the range. If a handle sticks out, a child might grab it or a passing adult might knock the pot over.

Many people use an oven cleaner and other potentially dangerous chemicals in the kitchen. These chemicals should be used according to the manufacturer's instructions and be kept in a locked cupboard.

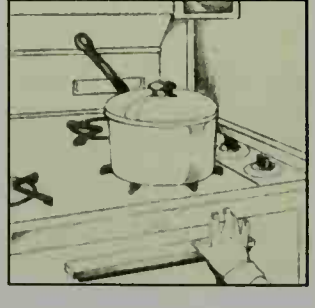
In the bathroom. Falls are one of the worst dangers in the bathroom. To prevent them, use a rubber mat or adhesive-backed vinyl strips called *appliqués* in the bathtub or shower stall. Also, install a sturdy handrail to the wall over the tub. Keep soap in a holder so you can reach it easily and to prevent it from falling underfoot. Use only nonskid bathroom rugs, and wipe up spilled lotions, other liquids, and powders to prevent slipping.

Medicine cabinets contain many dangerous items. For example, ordinary aspirin tablets are a common cause of poisoning among children. Use a medicine cabinet with a lock so that aspirin and other drugs can be kept away from youngsters. Never tell children that medicine tastes like candy. Whenever you take medication, read the instructions on the label carefully. Never take medicine prescribed for someone else. Throw out old medicines, but not where children might find them. In addition, such cleaning products as bleaches and drain cleaners

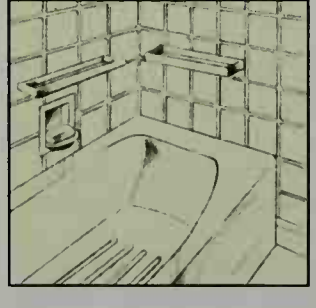
Safety at home Household accidents account for about a third of all accidental injuries and about a fourth of all accidental deaths in the United States each year. Almost all mishaps at home can be prevented by observing basic safety rules, such as those shown here.

WORLD BOOK illustrations by Bill and Judie Anderson

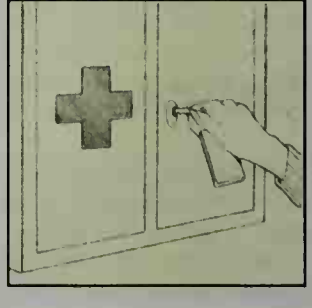
Use a ladder to reach high objects. Never climb on chairs, tables, or boxes.



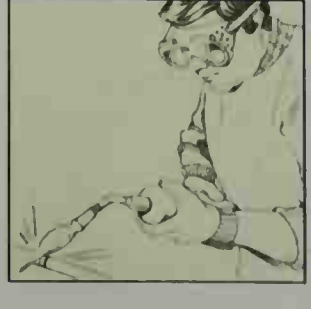
Turn pot handles toward the back of the range to avoid burns and scalds.



Install nonslip strips in the bathtub and provide handrails to prevent falls while bathing.

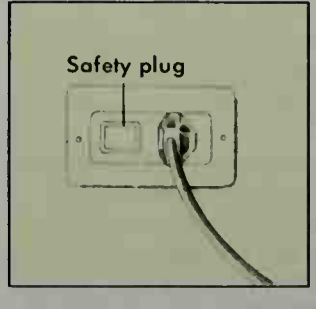


Keep medicine locked up, out of a child's reach. Never use unlabeled medicine.



Wear safety equipment, such as protective glasses, when using tools.

Wear shoes when mowing the lawn. Keep away from the blades of the mower.



Attach a safety plug to any unused electric socket that can be reached by children.

Install a smoke detector to help ensure safety in case of fire.

should be stored in a locked cabinet to keep them away from children.

Dry your hands thoroughly before using a hairdrier or any other electric appliance. Water is a good conductor of electricity, and you could be electrocuted by touching anything electrical while your hands or feet are wet. If you listen to a radio while taking a bath, use a battery-powered model. A plugged-in radio could electrocute you if the radio fell into the water or if you touched it with wet hands.

In utility areas. Safety in utility areas depends largely on the careful use of such dangerous items as power tools, appliances, and poisonous chemicals. The chemicals, which include cleaning products, paint thinners, and insecticides, should be kept in containers that have a childproof lid or cap. Store all hazardous items in a locked cabinet so that youngsters cannot get at them.

Do-it-yourself projects can be dangerous. Select your tools carefully, handle them with caution, and clean up thoroughly after you finish working. Dress properly when you work with power tools. For example, wear shoes instead of sandals. Tuck in your shirttail, and remove any ring, watch, or other jewelry that might get caught in the tool. Use safety glasses or a dust mask when sanding or grinding. Do not use power tools if you are tired or upset. Never leave a tool plugged in if children are present.

Dispose of an old freezer or refrigerator if it is not being used—or at least remove the door. A child might use the appliance as a hiding place, become trapped inside, and suffocate.

In the yard. If you use a spade or shovel when gardening, wear heavy work shoes to prevent foot injuries. Use work gloves to protect your hands from cuts and scratches. Learn to recognize poison ivy so you can stay away from it. If you use a fertilizer, pesticide, or weed-killer, avoid breathing the dust or spray and try not to get it on your skin.

When using a lawn mower, keep your feet away from the machine and never pull it toward yourself. The mower could run over your foot and gash it. Before mowing, remove stones, pieces of wire, and other small objects from the lawn. The blades of the mower can hurl such objects like bullets. If you have a power mower, never clean the grass chute while the motor is running.

Keep your lawn and garden tools in a garage or shed. Never leave them lying around where someone might step on them and be hurt.

If you have a swimming pool, guard it with a fence and a locked gate. Make sure the pool is supervised whenever anyone uses it. People who use the pool should know such safety techniques as how to dive properly and how to use lifesaving equipment. Keep the pool drained during periods when it is not used.

Safety with electricity. Electric tools and appliances are conveniences throughout the home. But they must be used carefully. Careless use of electricity can kill you.

All tools and appliances that you buy should have the seal of approval from Underwriters Laboratories (UL). This nonprofit organization tests electric products and approves only those that meet its standards of safety.

Use electric products carefully and follow the manufacturer's instructions. Never operate a power tool in the rain or in a damp area.

Pull the plug before you clean or repair an electric tool or appliance, and before changing the accessories of a power tool. Let a qualified repair service handle complicated repairs.

All electric outlets should be covered if any children in the home could reach them. Special plugs can be installed to cap unused sockets.

Safety from fire. Most of the deaths and injuries that are caused by fire occur at home. Some simple precautions can help keep your home—and the people in it—safe from fire.

Keep matches and flammable materials away from children. Never allow youngsters to play with fire. Check all electric wiring and replace any that seems worn or defective.

Clear out rubbish, old clothing, and other unused items from the attic, basement, closets, and other storage areas. A fire could easily start there.

Gasoline and other flammable liquids, such as paint and furniture polish, should be stored in tightly covered containers. Keep such items away from the stove, fireplace, and other sources of heat. Put a screen in front of the fireplace to prevent sparks from flying out.

Cigarettes and other smoking materials must be put out completely, using ashtrays. Never allow anyone to smoke in bed.

You can help ensure your family's safety in case of fire by installing one or more smoke detectors. These devices sound an alarm at the first sign of smoke. Plan an escape route from each room and hold a home fire drill regularly. All exits must be kept clear at all times.

Other precautions must be taken in every room of your home. One of the most important safety defenses is good housekeeping. Do not leave toys, shoes, and other objects on the floor where someone could trip over them. Tools and household cleaners should never be placed where children can get at them. For the greatest safety, keep everything in its proper place. After you have used an item, put it away immediately.

If you have firearms in your home, keep them unloaded and lock them in a rack or cabinet. Ammunition should be locked in a separate place.

Good lighting is important throughout the home, but it is especially vital in hallways and other heavily traveled areas. Night lights can help promote safety in bedrooms and bathrooms.

The burning of oil, gasoline, and certain other fuels may produce deadly carbon monoxide gas. To guard against carbon monoxide poisoning, never leave an automobile engine running in a closed garage. Fuel-burning stoves, heaters, and other appliances should be used only in well-ventilated areas.

Safety at school

School officials try to make their institution as safe as possible. They conduct safety training programs for students and teachers and hold regular fire drills. State and local laws require schools to provide clearly marked exits, fire escapes, and first-aid equipment.

However, accident prevention remains the responsibility of each student and teacher. Everyone must work together to make a school free of hazards.

In corridors and on stairways, many accidents occur because students are rushing to get to the next

WORLD BOOK photos by Steinkamp/Ballogg

At school, safety rules help prevent accidents on stairways. Never run or shove on stairs, *left.* Keep to your right, take one step at a time, and use the handrail to steady yourself, *right.*

class or to go home. You can lessen the danger of an accident by walking, not running, in corridors. Stay to the right, and do not crowd or shove. Never throw paper or other objects on the floor where someone might slip on them and fall. On stairways, never take two or more steps at a time. Use each step and, if necessary, hold the handrail to steady yourself.

In classrooms, keep your feet out of the aisles. Do not leave scissors or other pointed tools on chairs or desks where they could injure someone. Do not throw such items as pencils, pens, or paper clips at other students. Thrown objects can cause serious eye injuries. Do not push or crowd when entering or leaving a classroom. Help prevent accidents by reporting broken chairs, desks, and other equipment.

In gymnasiums and on athletic fields. More accidents occur in sports than in any other school activity. Teachers and coaches want to protect you, and you should follow their instructions and advice. Warm up to loosen your muscles before taking part in any physical activity. Learn how to fall safely. Try not to lose your temper during the rough play and physical contact of sports. Your anger could result in an injury to another player—or to yourself.

Each sport involves different safety precautions. If you play football, be sure to wear proper protective equipment. Baseball players must try to avoid collisions with other players, being hit by a bat or ball, and being spiked while sliding. In basketball, the chief hazards include collisions between players; twisted ankles; and running into walls, seats, or other structures.

In other school areas. Safety precautions are essential in science laboratories. Each lab should be equipped with one of two types of fire extinguishers—liquefied gas or dry chemical. Such fire extinguishers, unlike those filled with water, can be used on oil, grease, or electric appliances that catch fire. Every laboratory should also have first-aid equipment, a safety shower, and a spray for rinsing the eyes or face. When working on certain projects, students should wear a lab apron and an eye or face shield.

The art room needs good ventilation to remove the dust involved in making ceramics and the toxic vapors produced by silk-screen printing. Ceramics students also should wear dust masks.

The woodshop has many dangerous tools that must be stored carefully so they will not fall and cause injuries. All power saws must have a guard so that the user's hands cannot touch the blade. Students should wear safety glasses. Floors must be kept as free as possible of sawdust, grease, and scraps or chips of any material.

Safety in recreation

When people are having fun, they may not think about safety. Many are injured or even killed because they did not take precautions during recreational activities. In all such activities, know the limits of your strength and skill and do not try to exceed them. Never take chances. Be considerate of others. Wear the proper clothing for each activity, and use only equipment that is in perfect condition.

In winter sports, people must protect themselves against the cold in addition to taking the precautions involved with most other sports. A special hazard is a condition called *hypothermia,* in which the body temperature falls below its normal level of 98.6° F. (37° C). The symptoms of hypothermia include uncontrollable shivering, slurred speech, stumbling, and drowsiness. If left untreated, the condition may lead to death. Hypothermia can occur even if the temperature is above freezing, especially if a person's clothing is wet.

To help prevent hypothermia, wear wool clothing. Wool provides better insulation than other fabrics do. Wear loose garments that do not restrict the circulation of the blood. Several layers of light clothing are better than one heavy layer. Cover your head, hands, and feet because they lose heat quickly.

Snowmobiling is increasingly popular in many northern climates and has led to a large number of accidents. Speeding causes many snowmobile mishaps. Never go faster than the safe speed for your vehicle, and never drive too fast for the snow conditions. A snowmobile should not be operated in less than 4 inches (100 millimeters) of snow. If possible, drive only in daylight. About three-fourths of the fatal snowmobile accidents occur after dark. Be especially careful when crossing roads and watch for such obstacles as tree stumps, fallen logs, and hidden branches.

Skiing causes thousands of broken bones, sprains, and other injuries every year. To help prevent skiing accidents, use the proper ski equipment, including well-fitted boots, and keep your gear in good shape. If you are a beginner, be sure to get expert instruction. Go on difficult slopes only if you are an experienced skier in good physical condition. Stay with other people when skiing. If you are injured while alone, it may be difficult for someone to find you.

Sledding. Examine your sled and repair any broken parts or split wood. Sharp edges should also be eliminated before you go sledding.

Choose your sledding area carefully. Do not sled on streets, where you might slide into the path of an automobile. Steep hills are dangerous because you might go too fast and be unable to stop. Do not go sledding on frozen ponds or lakes if the ice could break under your weight. The ideal spot for sledding is a broad, gently sloping hill that is free of trees and far from any road.

Ice skating. In the United States, thousands of people a year suffer injuries while ice skating. Skaters may trip on bumps in the ice, collide with other skaters, or fall through thin ice. Beginners need expert instruction, and all skaters should keep their skates in good condition.

In water sports. Drowning is one of the leading causes of accidental death in the United States. In the United States, several thousand people drown yearly, many while they are swimming or boating.

Swimming. Never swim alone. You might get a cramp or be injured, and you could drown before anyone realizes you are missing. Swim only in areas protected by lifeguards. If you are a weak swimmer, stay in shallow water and use an inner tube, water wings, or other device to help stay afloat. Do not swim when you are chilled, overheated, or tired. Stay out of the water during thunderstorms and other severe weather. Children must be watched closely when in or near the water.

Never attempt a swimming rescue unless you are a trained lifeguard. Many drowning people struggle and pull their would-be rescuers down with them. However, you might be able to help a swimmer in distress without entering the water. If you are near enough, extend a fishing pole, tree branch, or similar object and pull the swimmer to safety. Keep your body low to avoid being pulled into the water. If the person is too far to reach, throw a life preserver; a large, empty picnic jug; or anything else that will help the swimmer float.

Boating. The chief causes of boating accidents include speeding, poor judgment, and recklessness. Boaters should know the safety limitations of their craft and never exceed the safe speed or the maximum number of occupants. The U.S. Coast Guard establishes and enforces boating regulations. These rules cover such matters as the use of warning lights and the right of way when boats approach each other. Federal law requires boats to have a Coast Guard-approved life preserver for each person aboard.

Safety on the job

In 1912, about 20,000 workers in the United States lost their lives on the job. Today, with a work force more than twice as large, the nation has far fewer job-related accidental deaths—about 5,000 a year. More than a third of these deaths occur in motor vehicles. Employers have made great efforts to provide safe workplaces because job safety is good business. The more workers a company can keep safe and healthy, the greater its profits will be.

Despite safety programs, U.S. workers suffer more than 3 million disabling injuries annually while at work. Job mishaps result in over 100 million lost workdays and cost the nation more than $100 billion a year.

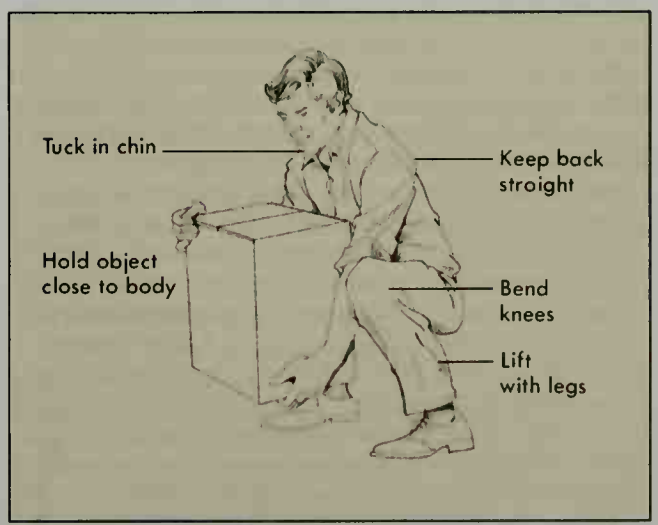
The careful use of tools, including scissors, knives, hammers, and screwdrivers, is important for all employees, regardless of where they work. Use the right tool for the job, and use it correctly. Keep tools in good condition, and store them in a safe place. You should also lift heavy objects properly to avoid sprains and strains. Bend your knees to grasp the object, hold it close to your body, and use your leg muscles rather than your back to lift the load. Safety experts recommend special steps to reduce the number and cost of injuries in manufacturing plants, mines, and offices.

In manufacturing plants, employers protect their workers with a wide range of safety devices and regulations. For example, most machines have guards over their moving parts. Most plants also have sprinkler systems or other devices to control fire, barriers to prevent falls, and equipment to get rid of dust and fumes. Many workers in plants are required to wear protective equipment, including goggles, ear protectors, safety helmets, fire-resistant clothing, and steel-toed shoes.

Professional safety engineers work to control or eliminate hazards in many manufacturing plants. They perform regular safety inspections and recommend steps to remove any dangers they find. Safety engineers also conduct safety-training classes for employees. In plants that do not have a full-time safety engineer, committees made up of workers and managers perform safety inspections.

Workers in manufacturing plants must share the responsibility for safety. They should inspect their workplace and report any hazards that might cause an acci-

Recreational activities require certain safety precautions. When sledding, dress warmly and use a gently sloping hill. Always stay near a companion when swimming.



WORLD BOOK illustrations by Bill and Judie Anderson

Safe lifting is an important part of job safety. Many people suffer injuries by lifting a heavy load improperly. This illustration shows the proper way to lift a heavy object.

dent. Employees also should operate machinery correctly and never smoke in areas where smoking is banned.

In mines, the number of accidental deaths has dropped by about half in the United States since the late 1960's. But about 30,000 miners and quarry workers yearly still suffer disabling injuries. The Mine Safety and Health Administration, a federal agency, sets and enforces safety standards for mines. Safety engineers work to educate miners in basic safety rules, including procedures for the use of machinery and explosives.

In offices, the level of safety is higher than in factories or mines. Nevertheless, office workers must obey basic safety rules. For example, they should walk, not run, on stairways, and they must operate machines and other equipment correctly. Fire safety is especially important in high-rise buildings. Many companies hold fire drills to help familiarize their employees with emergency exits and the procedures to follow in case of danger.

Some office staffs get instruction in *cardiopulmonary resuscitation* (CPR), an emergency procedure performed on victims of a heart attack. Cardiopulmonary resuscitation can keep a person alive until medical help arrives.

Safety in transportation

Motor vehicle safety. Accidents involving motor vehicles are the leading cause of accidental death in the United States. Despite continuous efforts to make automobiles and highways safer, the number of accidents keeps rising.

In the United States, more than 40,000 people a year die in motor vehicle accidents, and over 2 million suffer injuries. These accidents cost the nation approximately $200 billion annually. In Canada, about 2,000 people a year die in motor vehicle accidents.

You can increase your safety by following commonsense rules. Fasten seat belts—or children's car seats—to help prevent injuries and save lives. Obey the speed limit. Treat other drivers courteously. Signal when you plan to turn or change lanes. Stay a safe distance from other vehicles. Keep your car in good running condition. Never drive under the influence of alcohol or drugs, or if you are tired or upset.

Safety engineers work to improve vehicle construction, highway design, and traffic signs. But each individual motorist has the chief responsibility for safety. Most traffic accidents result from careless driving. Driver education is one of the most valuable tools in traffic safety. People who have completed a driver education course have fewer accidents than other motorists do.

Motorcyclists should wear safety helmets and obey the same traffic rules followed by automobile drivers. They also should drive at speeds that are safe for their motorcycles and for road conditions.

Bicycle safety. Only one person at a time should ride on a bicycle built for a single rider, and never attempt stunts while biking. Obey traffic signs and signals. Ride in the same direction as the automobile traffic and never hitch a ride by holding on to a motor vehicle. Always signal before you turn a corner or stop. Equip your bike with reflectors and lights if you ride at night.

Pedestrian safety. In the United States, motor vehicles kill about 6,000 pedestrians and injure about 85,000 each year. Many victims of these accidents are hit while crossing a street in the middle of a block, away from a crosswalk. Large numbers of them had been drinking alcoholic beverages before being struck. You can help avoid injury or death by crossing streets only at intersections. Obey traffic lights and look both ways before you cross. Walk on the sidewalk rather than in the street.

Children should never play in the street. They also can protect themselves from being hit by stopping and looking in both directions before chasing a ball or anything else into the street.

Safety in public transportation. People are much safer when using public transportation than when riding in private vehicles. The operators and crews of buses, trains, airplanes, and other vehicles used in public transportation are trained to protect the safety of their passengers. As a result, the accident rate for public vehicles is extremely low. In the 1990's in the United States, as few as 11 and as many as 329 accidental deaths occurred each year for passengers on scheduled airlines. About 10 passengers died each year in train accidents. Passengers can help lower the accident rate even further by not distracting the operator of the vehicle with conversation. In addition, passengers should practice common courtesy with those who are riding with them.

Safety in public places

An accident can occur wherever people congregate. However, a few precautions can help keep you safe in theaters, restaurants, and other public places. Always locate the emergency exits as soon as you enter a public building. Select the one you would use in case of a fire or some other disaster. Laws require exits to be well marked and lighted.

Be especially careful in crowds. Never push or shove.

Fisher-Price, Inc.

A child safety seat, used correctly, helps prevent injuries in automobile accidents and may save a child's life. Traffic accidents are the leading cause of accidental death in the United States.

Carry an umbrella or any other pointed object in such a way that the object will not injure another person or yourself.

Safety during emergencies

An emergency may result from a natural disaster, such as a flood, hurricane, or earthquake; or from a collision, fire, or explosion. Such tragedies can strike so suddenly that it is difficult to be prepared for them. However, you can lessen the risks if you know what to do during a flood, hurricane, tornado, or earthquake.

During a flood. Leave the flood area as soon as a flood warning is announced. Do not be caught in a low-lying place. Take food and clothing with you.

When you return after the flood, have all electric lights and appliances checked before using them. Boil all drinking water until health officials announce that the water supply is safe. If your automobile was submerged, have a mechanic check it for water in the brakes, power steering, and elsewhere.

During a hurricane. Keep your radio tuned to a news station after learning that a hurricane warning has been broadcast. Board up your windows or protect them with special storm shutters or tape. If you have a boat, anchor it securely or take it to a safe place. Store drinking water in clean bottles and jugs, and fill the bathtub with water for later use. Make sure your automobile gasoline tank is full because service stations may not be able to operate for several days after a hurricane. But do not store gasoline in cans or other containers in your car or home.

Stay home if the structure is sturdy and on high ground. Otherwise, move quickly to a designated hurricane shelter. Stay home or in the shelter until an all clear has been broadcast. After the storm, avoid loose or dangling electric power lines and report them immediately to the power company.

During a tornado. If your area lies in the path of an approaching tornado, seek shelter in an underground structure, such as a basement, subway station, or parking garage. Stay out of the upper stories of buildings and away from windows. If you are in a building that has no basement, go to the lowest floor and lie flat, preferably in an interior bathroom or closet. Cover yourself with a rug, blanket, pillows, or other padding for protection against flying glass and rubble.

If you are inside a building, do not open any windows when a tornado is approaching. Scientists used to advise people to open windows during a tornado to equalize the air pressure between the building and the outside and so prevent the structure from exploding outward. Scientists now know that buildings are not damaged by the sudden pressure change and that the danger from flying glass is much greater if people open the windows.

If you are in a car, try to escape by driving at a right angle to the path of the tornado. If you cannot reach shelter or escape, lie in a ditch or other hollow place.

During an earthquake. If you are indoors when an earthquake occurs, take cover under a table or desk. Stay away from windows. If you are outside, move away from buildings, where you might be struck by falling bricks and other rubble. If you are in a car, stop immediately but stay in the vehicle.

Working for safety

Safety is everyone's responsibility. Individuals, business and industry, government agencies, and private organizations share the obligation to protect people from needless injury and death.

Individuals have many safety responsibilities. For example, you should follow the manufacturer's instructions on all products. Purchase the proper tool or appliance for the work to be done, and never use a device beyond its limitations. Report any unsafe conditions in the community to the proper officials. Provide safety instructions to children. Drive safely.

Business and industry have responsibilities for the safety of customers and employees. They have an obligation to manufacture products that are safe to use, and they must give consumers complete instructions that will prevent accidents. Employers also have the duty to provide safe working conditions and safety education programs for employees, and to hold frequent fire drills. In addition, they must furnish safety equipment and have enough exits for use in an emergency.

Government agencies. Many United States government agencies are devoted chiefly to safety. The National Transportation Safety Board and the Transportation Security Administration work to ensure the safety of all types of transportation. The National Highway Traffic Safety Administration promotes safety in motor vehicles, on highways, and in highway equipment, such as traffic signals. The Consumer Product Safety Commission protects consumers from unsafe household goods. The Occupational Safety and Health Administration works to reduce hazardous job conditions. The United States Fire Administration develops new fire prevention and control techniques. The Nuclear Regulatory Commission works to ensure that nuclear power plants operate safely. Most state, county, and city governments also have departments concerned chiefly or partly with safety and health.

Private organizations in the field of safety are led by the National Safety Council, a nonprofit organization founded in 1913. The council produces educational materials on accident prevention and promotes safety legislation. The American Association of Automotive Medicine, an organization of medical professionals, works to reduce the number of highway injuries and deaths. The Insurance Institute for Highway Safety, supported by the insurance industry, aims to reduce traffic accidents through research and educational programs. The American Industrial Hygiene Association strives for accident prevention on the job. The American Society of Safety Engineers is the major professional organization for U.S. safety engineers and safety directors.

Charles C. Vance

Related articles in *World Book* include:

Safety at home

Botulism
Cooking (table: Some rules for safe food preparation)
Drug (table: Rules for using drugs)
Fire department (Fire prevention and fire safety)
Fire prevention
Match (Matches can be dangerous)

Safety in recreation

Boating (Boating safety)
Camping (Camping safety and courtesy)

Diving, Underwater (Dangers of underwater diving)
Drowning
Ice skating (Skating safety)
Sunburn
Swimming (Water safety)

Safety on the job

Business (Health and safety regulations)
Coal (Mine safety)

Safety in transportation

Airport (Air traffic control)
Automobile (Driving safely)
Bicycle (Bicycle care and safety)
Breath testing
Ship (Safety at sea)

Safety during emergencies

Civil defense
Lightning (Protection from lightning)
Tornado (Forecasting tornadoes)

Safety organizations

Consumer Product Safety Commission
National Safety Council
Occupational Safety and Health Administration
Red Cross (Health and safety training)

Safety devices

Air bag
Carbon-monoxide detector
Fire extinguisher
Life jacket
Lightning rod
Safety lamp
Safety valve
Smoke detector

Other related articles

Consumerism (The right to safety)
Electricity (Electrical safety)
Eye (Preventing eye damage)
Fire drill
Mushroom (Poisonous mushrooms)
Nuclear energy (Hazards and safeguards)
Poisonous plant
Woodworking (Tool care and safety)

Outline

I. **Safety at home**
  A. In the kitchen
  B. In the bathroom
  C. In utility areas
  D. In the yard
  E. Safety with electricity
  F. Safety from fire
  G. Other precautions
II. **Safety at school**
  A. In corridors and on stairways
  B. In classrooms
  C. In gymnasiums and on athletic fields
  D. In other school areas
III. **Safety in recreation**
  A. In winter sports
  B. In water sports
IV. **Safety on the job**
  A. In manufacturing plants
  B. In mines
  C. In offices
V. **Safety in transportation**
  A. Motor vehicle safety
  B. Bicycle safety
  C. Pedestrian safety
  D. Safety in public transportation
VI. **Safety in public places**
VII. **Safety during emergencies**
  A. During a flood
  B. During a hurricane
  C. During a tornado
  D. During an earthquake
VIII. **Working for safety**
  A. Individuals
  B. Business and industry
  C. Government agencies
  D. Private organizations

Questions

What common household products should be stored where children cannot reach them?
Why is it dangerous to swim or ski alone?
What does the Underwriters Laboratories (UL) seal mean on household products?
What are some of the precautions you can take to help keep your home safe from fire?
How could you rescue a swimmer in distress without entering the water yourself?
What is *hypothermia*? How can it be prevented?
Where should you seek shelter during an earthquake?
What are the two leading causes of accidental deaths in the United States?
What rules govern the safe use of electric products?
Where does safety start?

Additional resources

Level I

Chaiet, Donna, and Russell, Francine. *The Safe Zone: A Kid's Guide to Personal Safety.* Morrow, 1998.

Gutman, Bill. *Be Aware of Danger.* 21st Century Bks., 1996. *Hazards at Home.* 1996.

Level II

Dyer, Gerri M., ed. *Safe, Smart and Self-Reliant: Personal Safety for Women and Children.* Safety Pr., 1996.

Heberle, David, and Scutella, Richard M. *The Complete Guide to Making Your Home Safe.* F & W Pubns., 1995.

Safety, Committees of. See Committees of Safety.

Safety belt. See Automobile (Problems of safety).

Safety Council, National. See National Safety Council.

Safety lamp is a lamp designed to warn coal miners of the presence of firedamp, a gas that can cause destructive mine explosions. Firedamp is composed chiefly of methane and air. It is colorless and odorless. The methane forms when plants decay during the coal-forming process. Coal-mining operations can release firedamp.

The safety lamp burns oil. Inside the lamp, a wire gauze cylinder of fine mesh forms a cage around the flame. Firedamp can be detected by lowering the wick on the lamp. If firedamp is present in the mine, a pale blue flame will appear around the central flame. This blue flame warns the miners to get away from that section of the mine immediately.

The heat of the flame will not pass beyond the gauze covering and light the gas on the outside until the wire becomes as hot as the flame. The wire around the miner's safety lamp has good conducting power and will not heat up before the miner has time to escape.

The majority of safety lamps are locked in order to prevent miners from opening them. Some of the lamps go out when they are opened. Firedamp detectors based

Photri from Marilyn Gartman

A miner's safety lamp detects the presence of firedamp but will not ignite the gas that may surround it.

on electricity and light have been invented. However, the safety lamp is still widely used by miners.

The safety lamp is based on a principle discovered by the English chemist Sir Humphry Davy. He made the first successful safety lamp in 1815. William Hustrulid

See also **Damp; Davy, Sir Humphry.**

Safety pin. See **Pin.**

Safety valve is attached to a steam boiler to release some of the steam if the pressure becomes higher than the boiler can safely stand. It consists of a cone-shaped vent into which a plug is fitted. This plug is held in place by a lever bearing a weight. The maximum steam pressure in the boiler can be increased or decreased by shifting the weight on the lever. Many safety valves use a spring instead of a weight. This is because a spring is less subject to accident. Spring safety valves are called *pop* safety valves. The tension of the spring can be regulated so that the valve will "pop" at any desired pressure. Hot water heaters also have safety valves. See also **Bismuth.** Alan H. Glenn

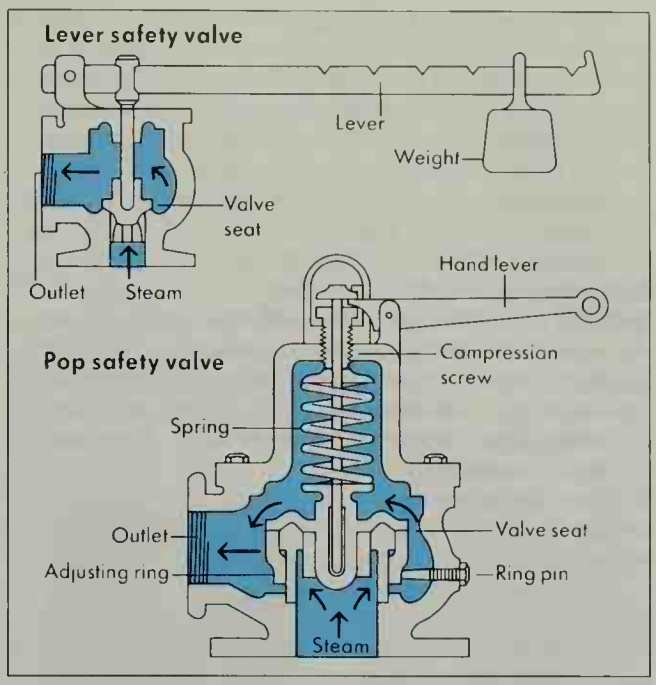
Safflower is a plant grown chiefly for the oil obtained from its seeds. The oil is used in cooking and processing foods, and in making paints and varnishes.

Safflower plants are cultivated in warm, dry regions, including Australia, India, Mexico, Spain, and the Southwestern United States. The plants grow from 1 to 5 feet (0.3 to 1.5 meters) high and have thistlelike flowers. Most varieties of safflowers have yellow or orange flowers, but some kinds have red or white flowers. The broad leaves are usually spiny. Safflower seeds are white and shaped like sunflower seeds.

Manufacturers use special machines to extract safflower oil from the seeds. Most manufacturers refine, bleach, and deodorize the oil after extraction. The oil has a light color and a mild flavor. Its high levels of polyunsaturated fat and low levels of saturated fat make it valuable as a salad oil and a cooking oil. It also is used in making margarine, mayonnaise, and shortening. Many varnishes and paints contain safflower oil as a drying agent. The oil combines rapidly with oxygen in the air to form a tough coating for the paint or varnish.

WORLD BOOK illustration by Christabel King

The safflower has large blossoms and thistlelike leaves and stems. Safflower seeds are used in making nutritious oil and meal.



Scientific classification. Safflower plants belong to the composite family, Compositae. They are *Carthamus tinctorius.*

Daniel R. Sullivan

Saffron, *SAF ruhn,* is a yellow dye and a food flavoring. It is prepared by hand harvesting and drying the stigmas and part of the styles of the purple autumn crocus known scientifically as *Crocus sativus* (see **Crocus**). About 60,000 flowers yield one pound (0.45 kilogram) of saffron. Saffron has a sweet odor, but tastes bitter. People in parts of Europe and India commonly use it to season foods. It is also used to color a variety of foods and textiles. James E. Simon

Saga, *SAH guh,* is the name given to a large body of literature written in Iceland between the 1100's and the 1300's. The word *saga* is related to the Icelandic verb meaning "to say" or "to tell."

There are many kinds of sagas. The earliest sagas were biographies of Icelandic bishops and Norwegian kings. The greatest achievement in this early historical writing was a complete history of the Norwegian kings composed by Snorri Sturluson in the 1200's.

The classic sagas were composed in the 1200's. These sagas are usually known in English as *Icelandic Family Sagas* and in Icelandic as *Sagas of Icelanders.* They are anonymous and vary in length from brief stories to the equivalent of full-length novels. Scholars once believed these sagas were transmitted orally from generation to generation until scribes wrote them down in the 1200's. But most scholars now believe the sagas were conscious artistic creations, based on oral and written tradition.

The sagas were composed during a period of civil war and social decline. They glorified the moral and social codes of a "golden age" that occurred between 850 and 1050 during the early settlement of Iceland. They are tales of legal disputes and blood vengeance, and provide a picture of social and cultural conditions at that time. The longest and finest of the classic sagas is *Njal's Saga,* a tale of honor, death, and vengeance.

During the 1200's, the European literature of chivalry began to influence Icelandic writers. Sagas became more romantic and fantastic. By the early 1300's, the nature of sagas had completely changed. These later sagas described the adventures of many traditional Germanic heroes such as Sigurd the Dragon Slayer and Rollo. Generally, critics consider these sagas inferior to the earlier ones. Richard N. Ringler

See also Snorri Sturluson; Sigurd.

Sagamore. See Micmac Indians.

Sagan, *SAY guhn,* **Carl Edward** (1934-1996), was an American astronomer, author, and educator. He gained fame as a leading popularizer of science. Sagan wrote several books, numerous magazine articles, and many scientific papers. He was the chief writer and narrator of "Cosmos," a popular public television series. The series dealt with a wide variety of scientific issues.

Wide World

Carl Sagan

Sagan's writings reflect his broad interests. In his works, he discussed the nature of the planets and their atmospheres, the origin and evolution of life on the earth, and the possibility of life on other planets. One of his best-known books, *The Dragons of Eden* (1977), deals with the evolution of the human brain. The book received the 1978 Pulitzer Prize for general nonfiction. Sagan's other works include *The Cosmic Connection* (1973), *Broca's Brain* (1979), *Cosmos* (1980), which is based on the television series, and *Contact* (1985), a novel.

Sagan was born in New York City. He received a Ph.D. degree from the University of Chicago in 1960. In 1968, he became a professor of astronomy and space science at Cornell University. C. R. O'Dell

Sage is the name of more than 750 species of herbs and shrubs. The *common sage,* also called *garden sage,* is known for its strong odor and bitter-tasting leaves and stems. It is an important herb for cooking, especially in the United States.

The common sage has white, woolly stems that grow to 2 feet (61 centimeters) tall. The grayish-green leaves have a rough, pebbled texture. The flowers grow in circular clusters at the tips of the stems and may be violet-blue, pink, or white. The common sage grows wild in the Mediterranean region and is raised commercially along the Pacific Northwest coast of the United States. People also grow this plant in their gardens.

WORLD BOOK illustration by John D. Dawson

Sage

Cooks use the leaves and stems of the common sage in making seasonings for sausages and cheeses, dressings for meat, and sauces. The plant also is brewed to make tea. The *white sage* has blossoms rich in nectar that bees use to make honey (see **Honey**). Donna M. Eggers Ware

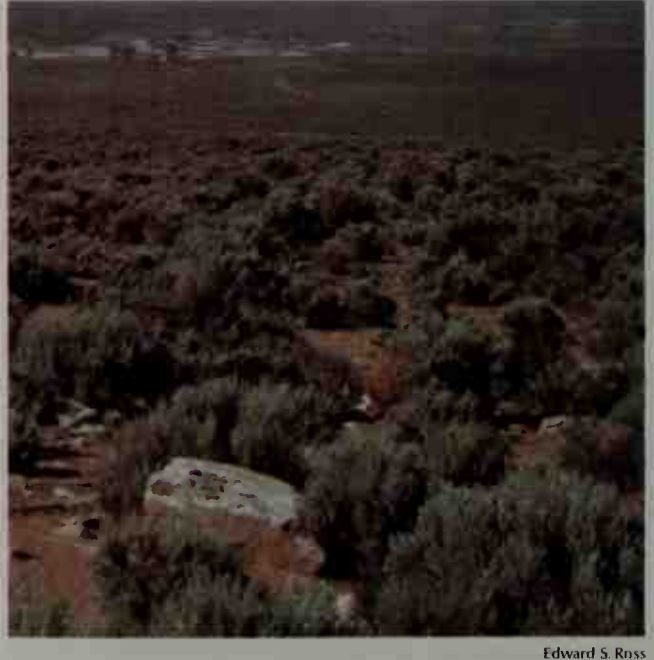
Scientific classification. Sage plants belong to the mint family, Lamiaceae or Labiatae. The scientific name for the common sage is *Salvia officinalis.* The white sage is *S. apiana.*

Sage, Margaret Olivia Slocum (1828-1918), was an American philanthropist. During the early 1900's, she donated about $75 million to educational institutions and charities. She financed her philanthropic activities with a fortune inherited in 1906 from her husband, Russell B. Sage, a banker and investor.

Margaret Sage's most important project was the establishment of the Russell Sage Foundation in 1907. This foundation supports research projects aimed at social and economic progress. She founded Russell Sage College in Troy, New York, and donated money to many other schools. She gave large sums to the Metropolitan Museum of Art, The American Museum of Natural History, and the New York Public Library, all in New York City. Her other gifts included a 70,000-acre (28,000-hectare) bird refuge on Marsh Island, which lies off the coast of Louisiana, and donations to hospitals. She was born in Syracuse, New York. June Sochen

Sagebrush is a shrub known for its sweet odor and bitter taste. It grows on the dry plains of the Western United States, particularly in northeastern California, eastern Oregon, Nevada, Utah, Wyoming, and Colorado. The plant may grow to any height from 2 to 12 feet (0.6 to 3.7 meters) and has a straight, stiff stem. The leaves are small and grow close together. The flowers grow at the top of the stem and may be yellow or white. Each consists of many tiny flowers called *florets.*

Sagebrush flourishes in the dry soil of the Western plains, where many other plants cannot grow. But it also grows on mountain slopes. Sometimes the heat and dryness in the summer dry up the plant so much that it shows no sign of being alive. Then, the wind often up-



Edward S. Ross

Sagebrush flourishes on the dry plains of the West.

roots the plant and blows it all over the plains. Sagebrush seeds are scattered in this way. Often sagebrush is the only plant life for great distances.

Sagebrush is not true sage, a plant used widely for seasoning (see Sage). Sagebrush got its common name from the sweet, sagelike odor of its crushed foliage. There are several types of sagebrush. Some are used as food for sheep in winter. Some people use sagebrush for fuel, since the dry wood burns with a hot flame and gives off a sweet-smelling smoke. Sagebrush can also be cultivated for domestic gardens. Anton A. Reznicek

Scientific classification. Sagebrush belongs to the composite family, Compositae. The scientific name for the common sagebrush is *Artemisia tridentata.*

Saginaw, *SAG uh NAW* (pop. 61,799; met. area pop. 403,070), is a manufacturing city in eastern Michigan. The Saginaw River divides the city. The city lies about 85 miles (137 kilometers) northwest of Detroit and about 20 miles (32 kilometers) south of Saginaw Bay. For location, see Michigan (political map).

The city's products include steering gears, brakes, fabricated metal products, chemical-processing machinery, and graphite products. The city has many wholesale firms. It also has four hospitals and serves as a medical center. Sugar beets are a major agricultural product in the Saginaw area, and sugar processing and shipping is a major industry. A number of grain elevators in Saginaw serve the farms, and the city also has one of the world's largest bean elevators.

Large ships can use the Saginaw River, which connects the city with Saginaw Bay—an arm of Lake Huron. An airport, a freight railroad, trucking firms, and buses serve the city. Institutions of higher learning in the Saginaw area include Saginaw Valley State College, Delta College, and Great Lakes Business College.

A fur-trading post was established at what is now Saginaw in 1816. A settlement called Saginaw was founded on the west bank of the river about 1820, following the building of Fort Saginaw. A second settlement, called East Saginaw, began on the opposite bank in 1849. The two united as Saginaw in 1889. The area's first lumber mill was erected in 1834. The area was a lumber center until its forests were cut down in the late 1890's. Saginaw is the seat of Saginaw County and has a council-manager form of government. Peter Gavrilovich

Sagittarius, *SAJ uh TAIR ee uhs,* is the ninth sign of the zodiac. Its symbol is an archer. Astrologers believe Sagittarius is ruled by the planet Jupiter, which they consider a wise, friendly planet. Sagittarius is a fire sign.

Astrologers consider people born under the sign of Sagittarius, from November 22 to December 21, to have the characteristics of Jupiter. Sagittarians are warm, outgoing, and relaxed, and they like to be surrounded by friends. Sagittarians also are generous and spend money impulsively. Jupiter makes them thoughtful, fond of exploring ideas, and capable of far-sighted decisions. They are cheerful and enthusiastic. In addition, Sagittarians are restless and like change and travel. They are independent and find it hard to accept discipline.

Christopher McIntosh

See also Astrology; Horoscope; Zodiac.

Sago, *SAY goh,* is a starch found in the spongy center, or pith, of various tropical palm trees. A type of flour, called *sago flour,* is made from sago. The largest supply of sago comes from the East Indies. Large quantities of sago are sent to Europe and North America for commercial cooking purposes. Sago flour is used mostly in making puddings and as a thickening for soups. The flour is nourishing and easy to digest. Sago is one of the principal foods of East Indian people.

The fruit of the palm trees from which sago is produced is not allowed to ripen fully. The full ripening completes the life cycle of the tree and exhausts the starch center. It leaves the trunk a hollow shell and causes the tree to die. The palms are cut down when they are about 15 years old, just before they are ready to flower. The stems, which grow 30 feet (9 meters) high, are split. The starch pith is taken from the stems and ground to a powder. A single palm yields about 800 pounds (360 kilograms) of starch. The powder is kneaded in water over a cloth or sieve. It passes into a trough where it settles. After a few washings, the flour is ready to be used in cooking. Sago is further refined and prepared for export. Margaret McWilliams

See also Arrowroot; Cornstarch; Tapioca.

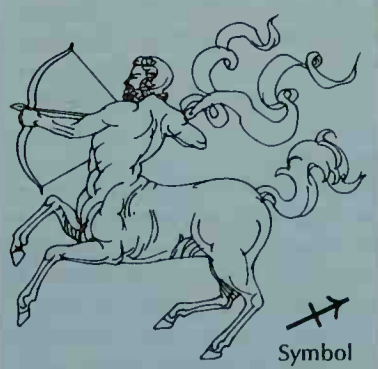
Saguaro, *suh GWAH roh* or *suh WAH roh,* is the largest cactus of the United States. This huge plant, often called the *giant cactus,* may stand as tall as 60 feet (18 meters) and weigh as much as 10 tons (9 metric tons). The saguaro grows only in the foothills and deserts of southern Arizona, southeastern California, and northwestern Mexico. It is the state flower of Arizona.

The saguaro has a columnlike trunk that measures from 1 to 2 $\frac{1}{2}$ feet (30 to 76 centimeters) in diameter. The plant also has a few large, upturned branches. Grooves and *ribs* (ridges) run lengthwise along both the trunk and branches. Little rain falls in the region where the saguaro grows. The plant soaks up and stores much water after the rare showers that do occur. The grooves and ribs expand and contract, much like an accordion, depending on the amount of stored water.

Padlike structures called *areoles* grow along the ribs. Each areole has from 15 to 25 long spines. The branches of the saguaro grow from certain areoles on the trunk. During May and June, the areoles near the tip of the

WORLD BOOK illustration by Robert Keys

Sagittarius—The Archer



Symbol

Birth dates: Nov. 22-Dec. 21.
Group: Fire.
Characteristics: Cheerful, enthusiastic, generous, outgoing, relaxed, warm.

Signs of the Zodiac

Aries
Mar. 21-Apr. 19
Taurus
Apr. 20-May 20
Gemini
May 21-June 20
Cancer
June 21-July 22
Leo
July 23-Aug. 22
Virgo
Aug. 23-Sept. 22
Libra
Sept. 23-Oct. 22
Scorpio
Oct. 23-Nov. 21
Sagittarius
Nov. 22-Dec. 21
Capricorn
Dec. 22-Jan. 19
Aquarius
Jan. 20-Feb. 18
Pisces
Feb. 19-Mar. 20

H. Coss, Saguaro National Park

Saguaros store water in their trunks and branches.

trunk and branches produce waxy, greenish-white flowers. These funnel-shaped flowers measure 3 or 4 inches (7.6 to 10 centimeters) long and bloom at night.

Bats, birds, and insects gather nectar from saguaro blossoms and, during the process, spread pollen from flower to flower. The pollinated flowers may then produce purplish-red, egg-shaped fruit. The mature fruit splits open, exposing watermelon-red pulp filled with black seeds. Many desert creatures eat the ripe fruit. The Indians of the region also eat the raw fruit or use it to make preserves and syrups.

Scientific classification. The saguaro belongs to the cactus family, Cactaceae. Its scientific name is *Carnegiea gigantea.*

Donald J. Pinkava

See also **Arizona** (pictures: State flower; Giant saguaro cactuses); **Cactus; Tree** (picture).

Saguaro National Park, *suh GWAH roh* or *suh WAH roh,* is in southern Arizona, east of Tucson. It is named for the *saguaros* (giant cactuses) that grow there. The cactuses may reach a height of 60 feet (18 meters) and weigh 10 short tons (9 metric tons). The park's wildlife includes coyote, black bear, and elf owl. The area became a national monument in 1933. It was made a national park in 1994. For its area, see **National Park System** (table: National parks).

Critically reviewed by the National Park Service

See also **Arizona** (picture: Giant saguaro cactuses).

Saguenay River, *SAG uh NAY,* is an important waterway in southern Quebec. The river begins at the eastern end of Lac St.-Jean. It flows east for about 100 miles (160 kilometers), and empties into the St. Lawrence River about 120 miles (193 kilometers) northeast of the city of Quebec. For location, see **Quebec** (terrain map).

The Saguenay River is not navigable for its first 35 miles (56 kilometers). It drops more than 300 feet (91 meters) in this stretch, which extends from Lac St.-Jean to Chicoutimi. However, this upper branch of the Saguenay has been harnessed for a power output of more than 1 million kilowatts.

The Lower Saguenay begins just below Chicoutimi, where the river forms a small inlet called Ha Ha Bay. The chief harbor on Ha Ha Bay is Ville de la Baie. The Port Alfred section of Ville de la Baie handles industrial traffic, and the Bagotville section has a military air base and a regional airport. The Lower Saguenay is navigable for the 65 miles (105 kilometers) from Chicoutimi to the St. Lawrence River. It becomes a fiord in this stretch, averaging 800 feet (240 meters) deep. Cape Trinity and Cape Eternity, the most famous of the river's cliffs, tower over the Lower Saguenay. Both cliffs are more than 1,600 feet (488 meters) high.

Tourist cruises have been conducted on the Saguenay River since 1849. Tadoussac, which lies at the mouth of the river, is a well-known resort area. Roger Nadeau

Sahara, *suh HAIR uh* or *suh HAHR uh,* is the world's largest desert. It covers about $3\frac{1}{2}$ million square miles (9 million square kilometers), an area roughly equal to that of the United States. The landscape of this vast African desert includes mountain ranges, rocky plateaus, gravelly plains, and sandy wastes. The barren desert is broken only by the cultivated land along the Nile River and in the scattered oases.

The Sahara extends more than 3,500 miles (5,630 kilometers) across northern Africa from the Atlantic Ocean to the Red Sea. It stretches more than 1,200 miles (1,930 kilometers) from north to south. The desert spreads over all of Western Sahara and the African part of Egypt. In addition, the Sahara covers parts of Morocco, Algeria, Tunisia, Libya, Sudan, Chad, Niger, Mali, and Mauritania.

The word *Sahara* comes from the Arabic word *sahra',* meaning *desert.* Parts of the Sahara have separate names, such as the Libyan and the Arabian deserts.

Land and climate. Mountains and uplands cover the central portion of the Sahara. The Ahaggar Mountains in Algeria rise 9,573 feet (2,918 meters) high. The uplands of a region called the Tassili-n-Ajjer lie northeast of those mountains. The Tibesti Mountains in Chad reach a height of 11,204 feet (3,415 meters).

© Ellefsen from FPG

The Saguenay River, in southern Quebec, flows from Lac St.-Jean to the St. Lawrence River. Tour boats carry sightseers past scenic cliffs along the Saguenay.

© The Image Bank from Getty Images

An oasis village of the Sahara lies at the foot of a huge sand dune. Oases such as this one in Algeria are scattered throughout the dry areas of the vast desert.

© Stone from Getty Images

A camel caravan in the Sahara, led by nomads of a Berber-speaking group called the Tuareg, crosses the desert in Mauritania. The Sahara has many vast seas of sand called *ergs.*

Scattered areas of barren, rocky plateaus and of gravelly plains make up most of the Sahara. The rest of the desert consists of vast seas of sand called *ergs,* which lie within large basins. In some places, the shifting sands of the ergs form dunes as high as 600 feet (180 meters).

Oases lie throughout the Sahara. The water in these fertile areas comes mainly from wells or springs. The Sahara has about 90 large oases, where people live in villages and grow crops. There are many small oases, some of which support only one or two families.

Major deposits of oil and natural gas lie under the Sahara in Algeria and Libya. These countries rank among the largest producers of the two vital fuels. The Sahara also contains unmined deposits of copper, iron ore, phosphates, uranium, and other minerals.

The Sahara has a dry, hot climate. The annual rainfall averages less than 4 inches (10 centimeters). Large areas of the eastern and western Sahara receive less than 1 inch (2.5 centimeters) of rain yearly. The mountainous central Sahara gets slightly more rain than other areas of the desert. Snow sometimes covers the mountaintops.

The Sahara is extremely hot during the day, but it turns cool at night. Daily summer temperatures often average above 90 °F (32 °C), and parts of the desert have daytime temperatures higher than 110 °F (43 °C). The highest official temperature in the world—136 °F (58 °C)—was recorded at Al Aziziyah, Libya, in September 1922. Daily winter temperatures in the Sahara average from 50 to 60 °F (10 to 16 °C).

People. The Sahara has a population of about 2 million. Large areas of the desert, such as the Great Western Erg and the pebbly plains of the Tanzerouft in Algeria, have no permanent settlements. Most Saharan people are Arabs or Berbers or have mixed Arab and Berber ancestry. The chief inhabitants of the Sahara include the Moors, the Tuareg, and the Toubou. The Moors have mixed Arab and Berber ancestry and live in the northwestern Sahara. The Tuareg, a Berber-speaking group, occupy the central mountains and uplands. The Toubou are a dark-skinned people of mixed ancestry who live in the Tibesti Mountains.

Most of the Saharan people are nomads who tend herds of sheep, goats, camels, and cattle. They occupy fairly distinct areas and travel systematically to use seasonally available water and pastures. Some tribes of nomads own land on the oases, but other people farm the land for them.

Most of the settlements on the oases have fewer than 2,000 inhabitants. The people grow dates, barley, wheat, and other crops. Some oases have thousands of date palm trees. But in areas that lack enough water, a single tree may be shared by several owners.

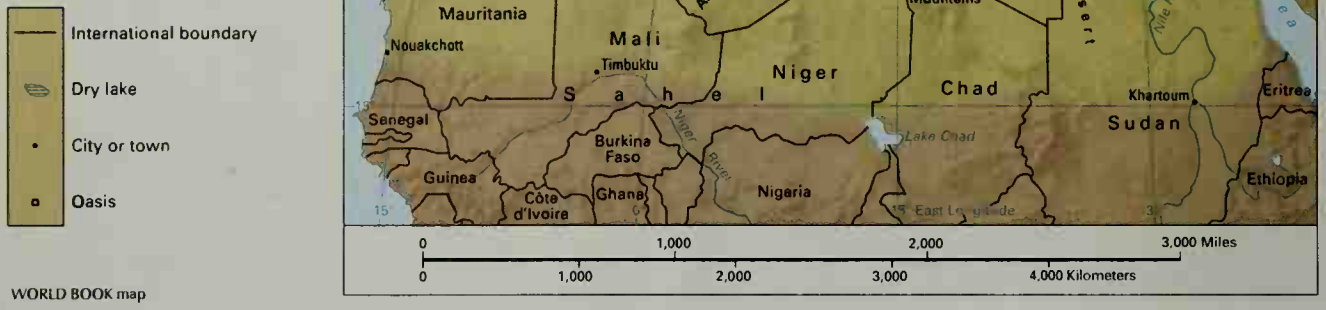
The Saharan people mainly use camels for transportation in the desert. The paved Trans-Saharan Highway crosses part of the desert from north to south in Algeria. Also in some areas, paved roads connect the principal oases. Motor vehicles can be driven across the desert along unpaved routes, but it is difficult. Commercial airlines serve many large cities within the desert and also fly over the Sahara en route to other destinations.

Plant and animal life is not as plentiful in the Sahara as it is in some other deserts. The grasses, shrubs, and trees that grow in parts of the Sahara have adapted to the dry conditions there. Some of the plants are *ephemeral* (short-lived). Their seeds lie in the ground and do not start to grow until rain falls. Then the plants grow rapidly and may complete their life cycle in six to eight weeks. Plants of the Sahara that live longer than a year obtain water in various ways. Some have long roots that reach deep into the soil and absorb moisture. Others take in moisture from the air through their leaves.

White gazelles and rare antelope called *addax* roam the sand dunes of the Sahara. Snakes, lizards, gerbils, and small foxes called *fennecs* also live in the dunes. Barbary sheep make their homes in the rocky plateaus. Most desert animals can go for long periods without

The Sahara

The Sahara stretches across northern Africa from the Atlantic Ocean to the Red Sea, and from the Atlas Mountains to the Sahel region. The desert covers parts of 10 countries.



WORLD BOOK map

water to drink. They get some water from the plants that they eat. Many of the small animals stay in their burrows during the day to avoid the heat. They search for food at night. See **Addax; Fennec; Gazelle; Gerbil.**

History. During the Pleistocene Ice Age, which ended about 10,000 years ago, the region that is now the Sahara had a much wetter climate. It included a number of lakes and streams. Elephants, giraffes, and other animals roamed the grasslands and forests that covered much of the region at that time. Until about 5000 B.C., the region was inhabited by people who lived by fishing and hunting. Later, the skills of farming and raising animals were introduced into the Sahara from the Middle East. Farming also developed separately in the southern Sahara in what is now Mali.

About 4000 B.C., the African climate became drier and the Sahara region began to turn into a desert. Ever since then, the Sahara has slowly expanded. Through the centuries, people have contributed to the spread of the desert by overgrazing the land and cutting down trees and shrubs along the borders of the region.

As the Sahara became drier, the region's original inhabitants moved south. A people called the Berbers, who lived along the northwest coast of Africa, gradually became established throughout the Sahara.

About the time of Jesus Christ, camels were introduced into the Sahara from the Middle East. Long camel caravans crossed the desert along trade routes controlled by the Berbers. Southbound caravans carried cloth, salt, glass beads, and other products. From the south, the caravans brought slaves, gold, kola nuts, leather, and pepper to markets in northern Africa.

The Roman Empire, which reached its peak from A.D. 40 to 235, included the northern borders of the Sahara. The Romans built cities and roads and brought better farming practices to the area. The Vandals, a Germanic people, conquered northern Africa in the 400's.

During the 600's and 700's, Arab tribes invaded northern Africa and began to convert the people to Islam, the religion of the Muslims. By the 1000's, the Arabs had spread Islam to the southern borders of the Sahara. Arabic eventually became the chief language of the Saharan people.

European exploration of the Sahara began in the early 1800's. France, Spain, Italy, and Britain occupied parts of the Sahara from the late 1800's to the mid-1900's. By the 1960's, all the areas occupied by the European powers, except Spanish Sahara, had become independent countries. Spain gave up control of Spanish Sahara in 1976, and the region came to be called Western Sahara.

Since 1968, severe droughts have struck much of the Sahel, an area of Africa that lies along the southern borders of the Sahara. Some people blame the droughts on expansion of the Sahara. But the droughts are actually part of normal, periodic climate variations in the area.

Donald E. Vermeer

Related articles in **World Book** include:

Africa	Berbers	Libya (picture)
Algeria (The Sahara; picture)	Camel	Oasis
Arabs	Desert	Sirocco
Bedouins	Egypt (terrain map)	Tuareg
	Harmattan	

Additional resources

Langewiesche, William. *Sahara Unveiled: A Journey Across the Desert.* Pantheon, 1996.

Scoones, Simon. *The Sahara and Its People.* Thomson Learning, 1993. Younger readers.

Sahel, *sah HEHL,* is a dry grassland in Africa. The Sahel lies south of the Sahara and extends through large parts of Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, and Sudan. Some geographers also consider certain desertlike regions in Eritrea, Ethiopia, Kenya, and Somalia to be part of the Sahel. A number of serious *droughts* (dry periods) have struck the Sahel. The area has been especially dry since 1968. Millions have died as a result of crop failures caused by the droughts.

Farmers in the Sahel face many problems. During some seasons, the area either receives no rain, or the rains come too late for the growing season. Occasionally, the Sahel receives heavy rainfalls that wash away the farmers' seeds. Other problems include livestock epidemics, attacks by locusts that destroy crops, and *ero-*

sion, the wearing away of soil by wind and rain. Much of this erosion results from the overgrazing of the grassland. Agricultural experts have developed methods to improve farming in drought-stricken areas such as the Sahel. But more economic assistance and cooperation by the area's governments are needed before these methods can be widely applied. Mark W. DeLancey

Saigon. See Ho Chi Minh City.

Sail. See Sailing; Ship; Ship, Model.

Sailfish is a large fish known for its big back fin, which it spreads out like a sail. The fish also has a long, pointed bill. Sailfish are dark blue on the back with a white or silvery underside. They range from 6 to 12 feet (1.8 to 3.7 meters) in length and can weigh more than 220 pounds (100 kilograms).

Sailfish live in ocean waters throughout much of the world. They spend their summers in *temperate* (mild) seas and travel to warmer tropical waters for the winter. Sailfish normally eat smaller fish and squid. They use their long bills to stun prey. Occasionally, people have observed groups of sailfish working together to capture prey. Female sailfish lay several million eggs, but only a few of the young survive into adulthood.

Sailfish rank as popular game fish. People commonly catch them in warm waters off the coasts of the United States and South and Central America. John E. McCosker

Scientific classification. The sailfish belongs to the billfish family, Xiphiidae, and makes up the genus *Istiophorus.* Its scientific name is *I. platypterus.* Some scientists believe another species of sailfish lives in the tropical Atlantic Ocean. Its scientific name is *I. albicans.*

See also Fish (picture: Fish of coastal waters and the open ocean).

Sailing is an exciting water sport. The thrill of sailing a boat in a fresh breeze attracts thousands of sailors to seashores, lakes, and rivers all over the world. They take to the water in sailboats that range in size from tiny dinghies to large yachts that can cross an ocean.

Many people enjoy racing their boats against other craft. For some, sailing brings the pleasure of leisurely hours on the water. Many people also love the challenge that sailing offers to their skill as sailors.

For hundreds of years, all great navies and merchant fleets of the world consisted of sailing vessels. Tall-masted ships with huge, billowing canvas sails traveled to all parts of the world. By the early 1900's, however, steamships had almost completely replaced sailing vessels for military and commercial purposes (see Ship [Sailing ships in the 1900's]). The development of sailing as a sport began when sailing ships declined in commercial importance.

Professional boatbuilders make most pleasure sailboats. For a number of years, many boats had hulls made of wooden planking fastened over frames. But newer materials, such as steel, fiberglass, and aluminum, are now used. However, some amateurs build small wooden sailboats at home. The parts are sometimes supplied in a kit, and the builder simply fits them together. This is an especially popular way of building small boats called *prams.* Most prams are about 8 feet (2.4 meters) long and have blunt ends similar to the baby carriages known as prams. They are the smallest practical sailboats and are good for new sailors learning sailing fundamentals.

The parts of a sailboat

Each part of a sailboat has a special name. Sailors take great pride in using the proper terms. The main parts of a sailboat include (1) the hull, (2) the spars, (3) the sails, and (4) the rigging.

Hull is the body of a sailboat. The front of the hull is called the *bow,* and the rear is called the *stern. Forward,* or *fore,* means *front,* and *aft* means *rear.* Almost all sailboats have either a *keel* or a *centerboard.* These flat pieces of metal or wood extend into the water from the bottom of the hull to limit movement to either side. A keel is fixed in place. But a centerboard can be raised or lowered through a slot in the bottom of a hull. Some boats, such as inland scows, may have two centerboards known as *bilge boards.* Other craft, such as sailing canoes, have *leeboards,* one on each side of the hull. Bilge boards and leeboards serve the same purpose as keels and centerboards. The boat is steered with the *rudder,* a fin that extends vertically into the water near the stern. On small sailboats, the rudder is turned with a long handle called a *tiller,* and on larger boats with a *wheel.*

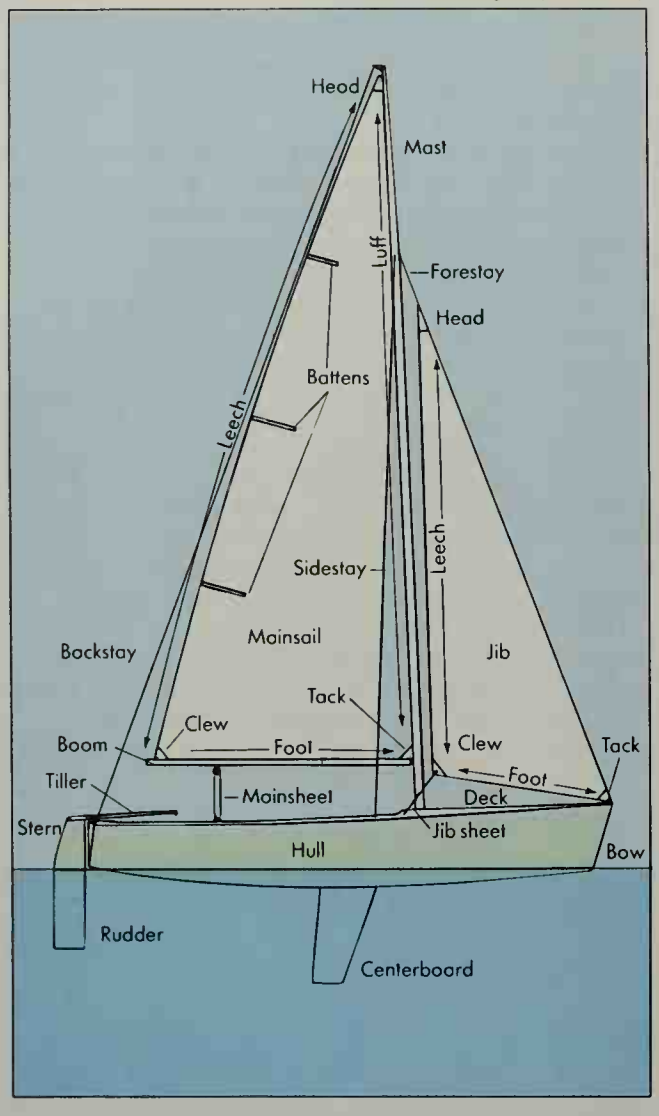
Spars are the poles that support the sails. They include masts, booms, and gaffs. *Masts* are the upright poles that hold the sails. The *mainmast* holds the largest sail. Some large sailboats also have a shorter mast, called a *mizzenmast,* toward the stern, or a shorter *foremast* toward the bow.

Artstreet

The thrill of sailing attracts many people to this exciting sport. These sailboats are competing in the Chicago-to-Mackinac Island race, held each July on Lake Michigan.

Parts of a sailboat

WORLD BOOK diagram by Kim Downing



Booms and *gaffs* are the poles that extend at right angles to the masts and hold the sails straight out. Booms are fastened to the bottom of the sail, and gaffs are sometimes fastened to the top.

Sails. The *mainsail* (largest sail on a sailboat) is fastened to the back of the mainmast. A smaller, triangular sail in front of the mainmast is called a *jib*. A large jib that overlaps the mast and stretches far back next to the mainsail is called a *Genoa jib*, after the Italian port where it was first used. The *spinnaker* is a large, balloon-shaped sail used for added speed when a boat sails with the wind. Spinnakers are often made in red, blue, and other bright colors. Dacron has largely replaced cotton as a material for sails. This material is strong and tightly woven, and holds its shape well no matter how strong the wind blows. But spinnakers are usually made of nylon, which is strong, light, and elastic. Nylon is too elastic for other sails.

Rigging includes the *lines* (ropes) used on a sailboat. *Standing rigging* is permanent and supports the masts. It includes *shrouds* that run from the sides of the boat to the mast, and *stays* that run from the bow and stern to the mast. *Running rigging* consists of the lines used to adjust the sails and booms. The lines that raise and lower the sails are called *halyards*. Those used to *trim* (adjust) the sails are called *sheets*.

Kinds of sailboats

Sailboats are classified according to their size and the way their sails and masts are *rigged* (arranged). There are many combinations of sails and masts. The most common rigs include catboats, sloops, yawls, ketches, and schooners. Most small sailboats are catboats and sloops. Larger sailboats, especially those capable of ocean trips, are often yawl, ketch, or schooner-rigged to break the total sail area into smaller, more easily managed parts.

Catboats and sloops, the most popular sailboats, are easy to sail and comparatively cheap. A *catboat* has one mast far forward in the bow, and only one sail. One type of small catboat especially popular with children is called a *sailing dinghy*. A *sloop* has one mast toward the middle of the boat, and two sails, a mainsail and jib. A large sloop with two jibs is sometimes called a *cutter*. *Inland scows* are popular on lakes. These light, fast boats are usually sloop-rigged. They have a rounded bow and a square stern, and are flat-bottomed. Scows usually have two bilge boards and two rudders.

There are several hundred classes of catboats and sloops. Each is built slightly differently as to the design and size of its hull, sails, and rigging. These sailboats are known as *one-design* classes. That is, all the boats in a particular class are built to exactly the same measurements. Each class has its own name, such as *Snipe, Penguin, Lightning,* and *Star*. The *Sunfish* and *Laser* are among the world's most popular classes. Each includes more than 100,000 boats in about 25 countries.

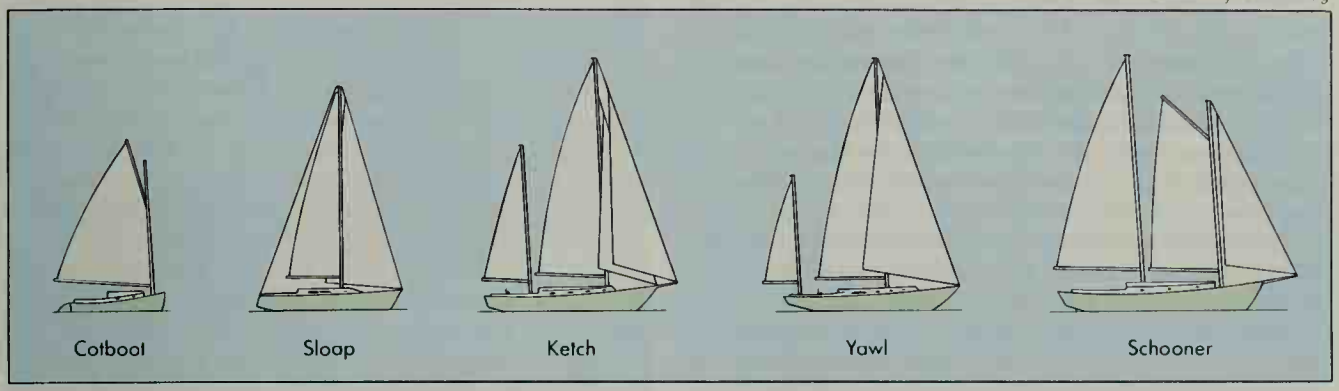
Yawls, ketches, and schooners are usually larger and more expensive boats. All have two masts and may be as long as 70 feet (21 meters). A *yawl* has at least three sails—a jib, a mainsail, and a mizzensail. The mizzenmast stands in the stern behind the rudder post. A *ketch* also carries three or more sails, but the mizzenmast is in

Otto Schatz, FPG

The wheel is used to turn the rudder and steer larger sailboats. Small boats are steered with a long handle called a *tiller*.

Types of sailboats

WORLD BOOK illustrations by Kim Downing



front of the rudder post. A *schooner* has a mainmast in about the middle of the boat and a foremast. It has the most sails, with one or more jibs, a foresail, and a mainsail. These larger boats may have comfortable living quarters that make them popular for long trips. If they have engines to help them sail into and out of harbors, they are called *sailing auxiliaries*.

Sailing a boat

Even a log raft with a goatskin tied to a pole will sail before the wind. To sail in other directions, a boat must be designed and rigged so that the force of the wind moves it across the wind or into the wind, as well as moving it with the wind.

Controlling direction. A boat with no means of control will travel straight *downwind* (in the direction toward which the wind is blowing). It will do this no matter which direction its bow or stern is pointing. It may even go sideways. Using a rudder is the first step in controlling a boat. With a rudder, the bow of the boat can be pointed in the desired direction.

But a rudder is not enough to control a boat. A boat must also have something to keep it from sliding sideways when moving across the wind. This is done with a keel, centerboard, bilge boards, or leeboards. Boats with keels can sail only in water deeper than the keel. Boats with centerboards and bilge boards can sail in shallower water, because the centerboard or bilge boards can be raised or lowered as needed. Leeboards are a simple way of changing a canoe or rowboat into a sailboat. They can be swung out of the water when not needed.

With a rudder for steering and a keel or centerboard to prevent sideward movement, a sailboat can travel in many directions. The bow of a sailboat is usually sharply pointed, so it can cut through the water easily.

Why a boat sails. A sail has curved panels sewn into it so it will be shaped like the wing of an airplane when the wind fills it out. The side of the sail to *leeward* (away from the wind) corresponds to the top of an airplane wing. The action of the wind blowing across this curved surface creates a lift similar to the force that enables an

Erik Anderson, Stock, Boston

A sailboat's *galley* (kitchen) often has all the appliances a boater needs to prepare a wide variety of hot meals.

Jon Feingersh, Stock, Boston

The living room of this sailboat resembles a luxury apartment, with modern furniture and fine wood paneling.

airplane to stay in the air (see **Aerodynamics**). In a sailboat, this lifting force becomes a pull away from the sail and toward the bow of the boat. At the same time, the wind also exerts a push against the other side of the sail. In this way, the action of the wind on the sail combines in two ways to force the boat forward. These forces make it possible to sail a boat in almost any direction, except directly into the wind and up to 45 degrees on each side of the wind direction.

Basic sailing maneuvers. There are three basic sailing maneuvers: (1) sailing into the wind, (2) sailing across the wind, and (3) sailing with the wind.

Sailing into the wind is called *tacking to windward, sailing on the wind,* or *beating to windward.* No boat can sail directly into the wind. If it does so, the sail flaps like a flag and becomes useless. But a boat can sail upwind by *tacking,* or following a zigzag course. In general, a sailboat can head to within 45 degrees of the direction from which the wind is blowing before its sail starts to *luff* (flap) and lose its driving force.

Sailing to windward requires great skill. The wind almost never blows constantly with the same force from the same direction. The speed with which a sailor's tacks bring a boat to a certain point upwind depends on the sailor's ability to feel the little shifts and changes in the wind, and to adjust the sails and the boat's direction, or course, accordingly.

Sailing across the wind, with the wind *abeam,* is called *reaching.* Sailboats can usually move faster when sailing across the wind than in any other direction. Some light sailboats with flat bottoms can move fast enough in a good breeze to lift out of the water and *plane* on the surface like a motorboat. This gives a great sensation of speed even though the boats seldom travel more than 20 miles (32 kilometers) per hour.

Sailing with the wind is called *sailing before the wind* or *running.* Contrary to what might be expected, running is not so fast as reaching. In running, the sail is simply pushed along by the wind and makes its own resistance. Many racing boats use spinnakers for added speed when running. These sails lift the boat along.

Trimming and tacking are two basic skills all sailors must learn in order to handle their boats effectively.

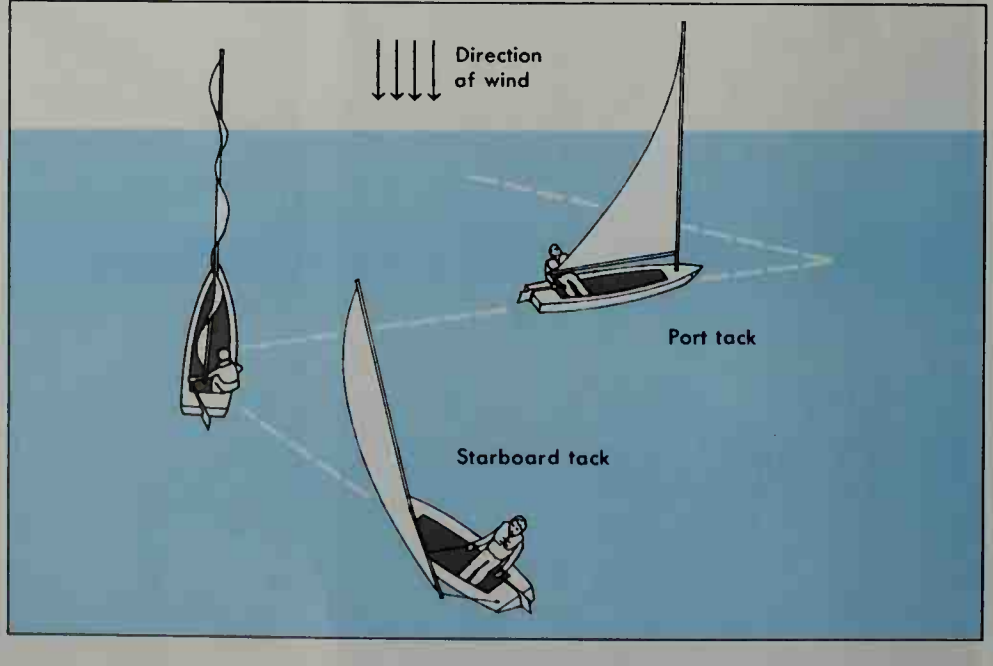
Trimming means adjusting the sails to obtain the full advantage of the available wind. A sailor must always know the wind direction in order to trim the sails correctly. When the boat is running before the wind, the mainsail is at right angles to the boat's direction. If a spinnaker is used, it is rigged out on one side of the mast on its own boom, called a *spinnaker pole.* The mainsail is on the other side of the mast. When the boat is sailing across the wind, the mainsail extends about halfway out from the boat, or at about a 45-degree angle to its direction of travel. When the boat is sailing into the wind, the sails should be trimmed nearly parallel to the boat's direction.

Small sailboats can easily *capsize* (overturn) if mishandled. Experienced sailors know where to place their weight and how to relieve dangerous pressure on the sails if a boat tips too far. This is done by *slacking off* (letting the sails out) so some of the wind spills from them. If a boat does capsize, the crew should hang on to it until rescued, unless it is of a type that can be righted and sailed. All sailors, especially those who are weak swimmers, should always wear life jackets. See **Swimming** (Water safety).

Tacking involves turning the boat so that the wind comes at it from the opposite side. When sailing into the wind, this is called *coming about.* In coming about, the bow is turned so that the wind crosses it. This is a comparatively safe maneuver. When the stern is to the wind, a turn that brings the wind to the other side of the boat is called *jibing.* Then, the wind crosses the stern quickly, and the boom slams across the boat. This quick shift of

Basic sailing maneuvers

Sailing requires skill, knowledge, and experience. Three basic maneuvers that all sailors must know are how to sail (1) into the wind, (2) across the wind, and (3) with the wind.



Sailing into the wind is also called *tacking to windward.* To sail into the wind, a boat *tacks* (zigzags) at a 45-degree angle to the direction of the wind. The boat must tack because if it sailed directly into the wind, the sail would flap wildly and be useless.

© Trev Kyle, West Stock

A boat tacks when sailing into the wind. The crew maneuvers the boat by changing the position of the rudder and the sails.

forces can capsize a boat if the maneuver is not handled carefully and with skill.

Sailboat racing

One-design races. The largest number of races are held for the catboats and sloops that make up the many one-design classes of boats. The boats usually sail over triangular courses in protected waters near a local yacht or boating club. These are evenly matched races, because all the boats in a particular class are designed and built alike. This makes the skill of the skipper and crew the most important factor in winning a sailboat race.

But the care with which a crew maintains its boat and prepares it for a race is also important. The way the crew members adjust the rigging and sails has much to do with a boat's speed. A bad paint job on a sailboat's bottom will slow it down, because the boat will not slip through the water easily.

Handicap races involve boats of different sizes and designs. All the boats cross the starting line together, but the smaller boats have a *handicap* (time allowance). A smaller boat can win even though it finishes far behind a larger boat. Most long ocean races for larger sailboats are handicap races. Some of the best-known races are from Annapolis, Maryland, to Bermuda; from Los Angeles to Honolulu, Hawaii; from Newport, Rhode Island, to Bermuda; and the Mackinac Races from Chicago and from Port Huron, Michigan, to Mackinac Island in the Straits of Mackinac.

America's Cup is the world's most famous sailing competition. A yacht representing a yacht club from one nation challenges the defending champion for a cup first won in 1851 by the schooner *America*. Elimination races determine the yachts that will represent the defending champion and the challenger. The first yacht to win a set number of races wins the cup. For more information, see **America's Cup**.

Patience Wales

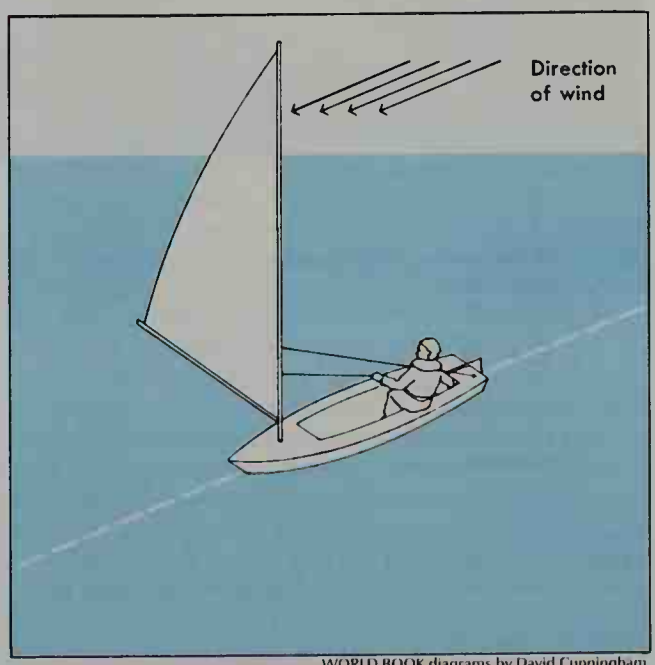
Related articles in *World Book* include:

America's Cup
Boating
Brig
Caravel
Catamaran
Chichester, Sir Francis
Clipper ship
Flag (Kinds of flags)
Frigate
Galleon
Galley
Junk
Lipton, Sir Thomas Johnstone
Olympic Games (table: Yachting)
Ship
Transportation (pictures)

Outline

I. **The parts of a sailboat**
   A. Hull
   B. Spars
   C. Sails
   D. Rigging
II. **Kinds of sailboats**
   A. Catboats and sloops

Sailing across the wind is also called *reaching*, or sailing with the wind *abeam*. A boat can usually sail faster when moving across the wind than it can with any other maneuver.



WORLD BOOK diagrams by David Cunningham

Sailing with the wind, called *running*, is the slowest basic maneuver. The sail is at almost a right angle to the direction in which the boat is moving, which creates great wind resistance.

Reuters/Archive Photos

The America's Cup is the world's oldest international sailing competition. Yachts representing two nations compete in a series of individual races to determine the winner of the cup. A series of elimination races is held to select the challenger. The winner of those races sails against the defending champion in the waters of the champion nation.

B. Yawls, ketches, and schooners

III. Sailing a boat
- A. Controlling direction
- B. Why a boat sails
- C. Basic sailing maneuvers
- D. Trimming and tacking

IV. Sailboat racing
- A. One-design races
- B. Handicap races
- C. America's Cup

Questions

How does a sloop differ from a yawl?
What sail was named after an Italian port?
In what direction would a boat be sailing if it is *reaching*? *Running*?
When would a *spinnaker* be used?
What is the world's most famous sailboat race?
Why is Dacron an excellent material for sails?
On what basis are the various sailboats classified?
How does a *sailing auxiliary* differ from the standard large sailboat?
Why is a *jibing* turn difficult for a sailboat?
How does a centerboard enable a sailboat to enter shallow water?

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Sailor. See Navy, United States; Ship.
Sailplane. See Glider.

Saint is a holy person who becomes a religious hero by exemplifying a virtue or virtues of his or her religion. The word comes from the Latin word *sanctus,* meaning *a holy one.*

The followers of a religion regard its saints as unusually blessed. They believe these saints are able to give special blessings and to exercise certain superhuman powers. All the world's major religions *revere* (deeply respect) saints, but in different ways. Some religions have formal procedures for officially granting sainthood to certain men and women. Other religions do not formally recognize saints, but they have religious practices that honor holy people.

Many people achieve sainthood because they played a major role in the history of their religion or because they symbolize a traditional feature of it. For example, Saint Paul converted to Christianity from another religion and became a great missionary who sought other converts. Some saints are martyrs who died for a holy cause. Many Christians who died rather than give up their faith during early Christianity are now considered saints.

A number of saints are considered especially close to God. Roman Catholics believe that the Virgin Mary is so loved by God that she rose bodily to heaven.

Some saints, such as Buddha, are believed to have gained superhuman or special knowledge about, or insight into, holy mysteries. Eastern Orthodox Christians revere Saint John Chrysostom for his wisdom.

Some people are revered as saints because before or after death they performed miracles and pleaded with God for blessings or curses on particular people. Others achieved sainthood because their *relics* (remains or possessions) or some place associated with them came to be regarded as holy.

Still others are considered saints because before or after death they became *demigods* (partly a god and partly human) and had divine powers. Before World War II, believers in one form of Shinto regarded the emperor of Japan as divine.

Non-Christian saints

Judaism forbids praying to any being other than God. But Jews honor saintly people as heroes. In Jewish worship, the heroic deeds of holy people may be recited as examples of faithfulness to God. Such early heroes as Jacob and David sometimes broke Jewish laws. But later Jewish saints were learned in the *Torah* (religious law) and firm in following its rules of behavior. Jewish saints have been called "toilers in the Torah." The most famous Jewish saints include Hillel the Elder and Akiva ben Joseph.

Islam credits supernatural powers only to *Allah* (God). All Muslims acknowledge as saints such heroes as Muhammad and Ali. The Islamic holy book, the Quran, does not provide for the worship of saints, but each locality cherishes a saint called *wali* (benefactor, companion, or friend). Muslim saints are considered to be close to God but not divine. The spiritual powers they exercised as living people increase when they die. Then, their influence centers on their tombs and relics, especially their robes. Muslims believe each saint can perform a special miracle. A visit to a saint's tomb, with its holy objects and often its pool or fountain, is believed to provide advice, to cure a disease, or to grant children to a childless woman.

The Oriental religions have a greater variety of practices and beliefs regarding saints than do the Western religions. Buddhism honors the buddhas and their close disciples, along with relics and sacred places associated with them. Buddhist monks and nuns recognize patron saints as special guardians, and Buddhist martyrs are honored as religious heroes. Hinduism has no official saints for all Hindus. There are many ranks of semidivine local or regional saints. A Hindu village, tribe, or religious order may raise its own heroes or protectors to sainthood. Confucianism has holy men who are *sages* (wise men) of intellectual and moral superiority. The most famous sage is Confucius. Shinto has no human saints or martyrs because its holy people are considered divine.

Christian saints

The more traditional Christian denominations emphasize the honoring of saints. The Eastern Orthodox Churches, the Roman Catholic Church, some Lutheran churches, and the churches of the Anglican Communion regard many of the same people as saints.

A *canonized* saint is a person whose name is included in a *canon* (official list). Christian saints were first considered saints by common agreement among people in a certain area, and later by regional bishops. Gradually, the authority to canonize saints for Latin Christians centered on the pope.

The earliest Christian writings call all believers *saints.* This practice has been renewed by several modern denominations, including the Mormons (Latter-day Saints). During the 200's, the term *saint* referred specifically to martyrs, and in the 300's to bishops. By the 500's, the term referred to all departed heroes and heroines of Christianity who were honored in worship services. In the early forms of honoring martyrs, local believers gathered at their tombs on the anniversaries of their deaths. The fame of certain saints gradually spread to other congregations, and by the 500's some famous saints were revered throughout the Christian world.

After many martyrs, bishops, monks, scholars, miracle-workers, and other heroes and heroines had entered the list of saints, their relics were considered able to give special blessings. Believers asked the saints to plead with God for special favors. The Christian saints were popularly regarded as holy before they became officially recognized as saints. During the Middle Ages, popular religious sentiment sometimes disregarded the difference between worshiping or adoring God and *venerating* (showing religious devotion to) saints. By the early 1500's, many people prayed to the saints and their relics for special assurances of salvation. Certain practices developed around the veneration of some Christian saints, but were later considered superstitious. For example, many people thought Saint Lazarus could cure measles if a person who had the disease prayed to him.

During the Reformation, both Protestants and Catholics attacked abuses in the worship of saints. Most Protestants refused to revere any persons as saints except certain heroes mentioned in the New Testament. After the Reformation, the Roman Catholic Church restated the manner in which followers could call on saints for

help or protection. Catholic saints were clearly ranked lower than God, and superstitious or other *impious* (disrespectful) practices regarding them were outlawed. Roman Catholics, members of Eastern Orthodox Churches, and some Protestants still ask saints to plead with God in their behalf.

Roman Catholic saints

Present Roman Catholic procedures of canonization were officially established between the late 1500's and the mid-1600's. A commission appointed by the church strictly examines the subject's life and works and any miracles associated with the person. If the investigation produces enough evidence, the person is eligible for *beatification*. That is, he or she may officially be declared "blessed." If further investigation produces proof of two miracles associated with the person, he or she may be canonized as a saint.

Canonization consists of declaring that a person believed to be holy was indeed a saint during his or her lifetime and is in heaven with God. This official status does not approve all that the individual said, did, or wrote. Among Roman Catholics, only the pope can grant official recognition to a person nominated for beatification or canonization. In 1969, the Vatican announced a revision of the church's liturgical calendar, which lists the feast days of saints celebrated by the church. The new calendar listed 58 saints. But many more saints could continue to be venerated locally. The Roman Catholic Church also made optional the celebration of the feast days of other saints.

Children of Catholic parents and many others are named after a saint, often the saint on whose day the child was born or baptized. That saint becomes the child's special guardian or patron. A number of cities, especially in the Western Hemisphere, are named after saints. They include Saint Louis, Missouri, and São Paulo (Saint Paul), Brazil. In many denominations, parish churches or congregations take the names of saints. Many Christians, recognizing that many holy men and women have never been canonized, celebrate them on All Saints' Day, November 1. John Patrick Donnelly

Related articles in *World Book*. See **Canonization; All Saints' Day**; and the table of popes with the **Pope** article. Other related articles include:

Albertus Magnus, Saint
Alphonsus Liguori, Saint
Ambrose, Saint
Andrew, Saint
Anne, Saint
Anselm, Saint
Anthony of Padua, Saint
Anthony of Thebes, Saint
Aquinas, Saint Thomas
Athanasius, Saint
Augustine, Saint
Augustine of Canterbury, Saint
Bartholomew, Saint
Basil, Saint
Becket, Saint Thomas
Bellarmine, Saint Robert
Benedict of Nursia, Saint
Bernadette, Saint
Bonaventure, Saint
Boniface, Saint
Brébeuf, Saint Jean de
Bridget, Saint
Cabrini, Saint Frances Xavier
Canisius, Saint Peter
Catherine of Siena, Saint
Cecilia, Saint
Christopher, Saint
Chrysostom, Saint John
David, Saint
Dominic, Saint
Drexel, Saint Katharine
Dunstan, Saint
Edward the Confessor
Elizabeth, Saint
Fisher, Saint John
Francis de Sales, Saint
Francis of Assisi, Saint
George, Saint
Ignatius, Saint
Irenaeus, Saint
James, Saint
James the Greater, Saint
James the Less, Saint
Jean Baptiste de la Salle, Saint
Jerome, Saint
Joan of Arc, Saint
Jogues, Saint Isaac
John, Saint
John the Baptist, Saint
Joseph
Juan Diego, Saint
Jude, Saint
Justin the Martyr, Saint
Louis IX
Loyola, Saint Ignatius
Luke, Saint
Mark, Saint
Martin of Tours, Saint
Mary
Matthew, Saint
Matthias, Saint
Michael, Saint
More, Saint Thomas
Neumann, Saint John N.
Nicholas, Saint
Pachomius, Saint
Patrick, Saint
Paul, Saint
Peter, Saint
Philip of Bethsaida, Saint
Rose of Lima, Saint
Sebastian, Saint
Seton, Saint Elizabeth Ann
Simon, Saint
Stanislas, Saint
Stephen, Saint
Swithin, Saint
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Thomas, Saint
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Vincent de Paul, Saint
Vladimir I
Xavier, Saint Francis
Youville, Saint Marguerite d'

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Saint Andrews lies on the east coast of Scotland between the cities of Edinburgh and Dundee. It is part of the North East Fife local government district, which has a population of 66,010. St. Andrews itself has about 16,000 people. For its location, see **Scotland** (political map). This town is sometimes called the *Capital of Golf.* The Royal and Ancient Golf Club, founded in St. Andrews in 1754, establishes many of the rules for the game. The oldest university in Scotland, the University of St. Andrews, was founded in 1411. A. S. Mather

See also **Scotland** (picture: The Royal and Ancient Golf Club).

Saint Andrews, New Brunswick (pop. 1,869), is often called Saint Andrews-by-the-Sea. St. Andrews lies on Passamaquoddy Bay, about 60 miles (97 kilometers) west of St. John, and about 1 mile (1.6 kilometers) east of the United States border. For the location of St. Andrews, see **New Brunswick** (political map). The many small islands in the bay and the ocean shoreline make the town a popular tourist center. Scientists at the Saint Andrews Biological Station conduct fishery research. St. Andrews was founded in 1784 by United Empire Loyalists (see **United Empire Loyalists**). T. W. Acheson

Saint Augustine, *AW guh STEEN,* Florida (pop. 11,592), is the oldest permanent settlement established in the United States by Europeans. It was founded in 1565 by a Spanish explorer, Pedro Menéndez de Avilés. St. Augustine lies in northeastern Florida, on the coastal waters of the Atlantic Ocean (see **Florida** [political map]).

Spain ruled St. Augustine for more than 200 years. Some historians believe that Spanish explorer Juan Ponce de León visited what is now the St. Augustine area in 1513. During the late 1500's, St. Augustine served as Spain's military headquarters in North America. The English naval commander Sir Francis Drake looted and burned the settlement in 1586. Spain ruled St. Augustine until 1763, when the British gained control. Spain again

Robert Lightfoot, Atoz Images

St. Augustine's oldest house, built in the early 1700's, reflects the city's rich history. Horse-drawn carriages transport tourists to the house and to other historic places in the city.

ruled the settlement from 1783 until 1821, when Florida became a territory of the United States.

The narrow streets and Spanish-style architecture of the oldest district of Saint Augustine reflect the city's rich history. Many of the old buildings have been restored to preserve the district's historical atmosphere. The Castillo de San Marcos (Fort of Saint Mark), a large, gray stone fortress built by the Spanish in the 1600's and now a national monument, dominates the city. This structure and many others in the city are made of *coquina,* a limestone formed of shells and coral.

St. Augustine became an important tourist resort when the railroad arrived in the 1880's. Today, tourism is its chief industry. Other industries include boatbuilding, fishing, and food processing. The city is the home of Flagler College and the seat of St. Johns County. It has a council-manager form of government. Peter O. Muller

See also **Fountain of Youth; Castillo de San Marcos National Monument; Florida** (Exploration and Spanish settlement; picture); **Menéndez de Avilés, Pedro.**

Saint Bartholomew's Day, Massacre of, was a slaughter of French *Huguenots* (Protestants). The massacre began in Paris on St. Bartholomew's Day, Aug. 24, 1572. It spread throughout France, and thousands of Huguenots were killed before the violence ended.

During the mid-1500's, the French Roman Catholics and Huguenots fought bitterly. The Huguenots had become so numerous that the Catholics feared they would take control of the French government. A civil war began in 1562 and lasted eight years. In 1570, the Peace of Saint-Germain granted the Huguenots liberty. But fear of the growing Huguenot political power led Catholic leaders to plot the assassination of Gaspard de Coligny. Coligny, a respected Huguenot leader, had become one of King Charles IX's chief ministers.

The attempt on Coligny's life caused great tension in Paris. Huguenots had flocked to the city to celebrate the marriage of their leader, Henry of Navarre (later King Henry IV of France), to the king's sister, Margaret of Valois. Henry of Guise, Coligny's enemy, led a group who murdered Coligny on St. Bartholomew's Day. Other well-known Huguenots were killed in Paris. Mobs then killed thousands throughout France. Henry of Navarre saved his life by becoming Catholic, but he resumed his Protestant faith a few years later. Donald A. Bailey

See also **Huguenots.**

Saint Bernard is a large, intelligent dog that became famous for rescuing lost travelers. The dog was developed during the 1600's by a group of monks in the monastery of St. Bernard, in the Alps of Switzerland. At that time, many people traveled in the Alps on foot. Some lost their way or became buried in sudden snowdrifts or snowstorms. The St. Bernard was trained to rescue such people. With its keen sense of smell, the dog could find people who were buried in the snow. After it had found the lost traveler, it called for help by barking. The dogs were also trained to guide travelers over treacherous trails, giving warning of dangerous footing. An English artist, Sir Edwin Landseer, painted a popular picture of the dog with a small cask hanging from a collar around its neck. But authorities say the St. Bernard never carried casks on rescue missions.

The St. Bernard is valued as a watchdog. It is also a good pet and guide for explorers. It is strong and tall, measuring about 26 to 30 inches (66 to 76 centimeters) high at the shoulder. It may weigh from 140 to 200 pounds (64 to 90 kilograms) and is one of the heaviest

WORLD BOOK photo

The St. Bernard is a good watchdog and pet.

dogs. The dog has a white and red or white and brownish-yellow coat. It may also have some black markings on its head. Its hair may be either long or short. The St. Bernard has a large, square head, a short muzzle, and a short neck. Critically reviewed by the American Kennel Club

See also **Dog** (picture: Working dogs).

Saint Bernard Passes are two high passes across the Alps. The Great St. Bernard Pass is on the border between Switzerland and Italy, and the Little St. Bernard Pass is on the border between France and Italy. For their locations, see **Switzerland** (terrain map). The Romans used the passes as military roads about 2,000 years ago. Today, motor roads cross the passes. Each pass has a *hospice* (refuge for travelers). The Great St. Bernard Tunnel for automobiles, which is about $3\frac{1}{2}$ miles (5.6 kilometers) long, links Italy and Switzerland. It was opened to

Bob and Ira Spring

Great St. Bernard Hospice stands in Great St. Bernard Pass in the Alps, on the Swiss border with Italy. The hospice has been a refuge for travelers for nearly 1,000 years.

traffic in 1964.

Great St. Bernard. The road leading across Great St. Bernard begins at Martigny, in the Rhône Valley. It follows the Val d'Entremont to an elevation of 8,100 feet (2,469 meters). The road then descends into northwestern Italy by way of Valle D'Aosta. The Great St. Bernard Hospice stands at the highest point in the pass. It was founded in the 1000's by Saint Bernard of Menthon. Augustinian monks offer refuge for travelers at the hospice. In the past, the pass became well known because the monks used their famous St. Bernard dogs to save the lives of many wayfarers during severe winter months. In normal winters, the road to the pass is only partially open, isolating the hospice from the outside world. Food and other necessities are brought to the hospice by truck in the summer. In the winter, necessities are flown in by helicopter. Many summer travelers visit the hospice, which has room for more than 300 people. But only those traveling on foot may stay.

Little St. Bernard lies about 25 miles (40 kilometers) southwest of Great St. Bernard. Its hospice also dates from the 1000's, and is nestled in the pass at an elevation of 7,178 feet (2,188 meters). Little St. Bernard is 10 miles (16 kilometers) south of Mont Blanc, the highest mountain in the Alps. Herbert H. Einstein

See also Alps; Saint Bernard.

Saint Christopher and Nevis. See Saint Kitts and Nevis.

Saint Clair, Arthur (1736-1818), was a Scottish American soldier and statesman. He served as a British Army officer in America during the French and Indian War (1754-1763). When the Revolutionary War in America broke out in 1775, he joined the colonial army and organized the New Jersey troops. St. Clair fought at Trenton and Princeton and became a major general. He commanded Fort Ticonderoga but did not try to defend it against General John Burgoyne. St. Clair was criticized for not defending the fort and was recalled from service.

St. Clair won a seat in the Congress of the Confederation as a representative for Pennsylvania in 1785. In 1787, he became president of the congress. That same year he became governor of the Northwest Territory. St. Clair led about 2,000 U.S. soldiers against the Miami Indians in 1791. But he was defeated in the Battle of Maumee, at what is now Fort Recovery, Ohio, and relieved of his command. In 1802, St. Clair resigned as governor. He was born in Thurso, in what is now the Highland Region of Scotland. Richard D. Brown

Saint Clair, Lake. See Lake Saint Clair.

Saint Cloud (pop. 59,107; met. area pop. 167,392) is a center of commerce and education in central Minnesota. The city serves as a hub for wholesale and retail trade, shipping, and services. St. Cloud lies on the Mississippi River, about 65 miles (105 kilometers) northwest of Minneapolis (see Minnesota [political map]).

St. Cloud ranks high in the production and processing of colored granite, optical lenses, and printed materials. Other industries include mail-order sales and food processing. The city is the home of St. Cloud State University and of the Stearns County Historical Society and Heritage Center.

Ole Bergeson, a Norwegian, staked a claim to the site of St. Cloud in the early 1850's. In 1853, John L. Wilson, a pioneer from Maine, paid Bergeson $250 for the 325 acres (132 hectares) where the business district now stands. Wilson named the settlement St. Cloud after a suburb of Paris, France. St. Cloud was a terminal on the stagecoach line from St. Paul, Minnesota, to Winnipeg, Canada, and on the Pacific Northwest Railroad. The settlement grew rapidly, and it became a city in 1856. St. Cloud is the seat of Stearns County. It has a mayor-council government. Clifford E. Clark, Jr.

Saint Croix. See Virgin Islands.

Saint Croix Island International Historic Site, on the Canadian border in eastern Maine, is the site of one of the first French settlements in North America. Explorers Sieur de Monts and Samuel de Champlain established a colony there in 1604. The colony was abandoned in 1605. The site is on St. Croix Island and on the southern bank of the St. Croix River. The United States Congress authorized the site as a national monument in 1949, but all the land was not acquired until 1967. In 1984, Congress made it an International Historic Site.

Critically reviewed by the National Park Service

Saint Denis, Ruth (1879-1968), was an American dancer, dance teacher, and *choreographer* (creator of dance). She devoted herself to proving that dance could express "the noblest thoughts of man."

Photo by Lou Goodale Bigelow
(The Dance Collection, New York Public Library)

Ruth St. Denis was fascinated by Asian dances. She danced *Siamese Ballet* with her partner, Ted Shawn.

Ruth St. Denis was born on Jan. 20, 1879, near Newark, New Jersey. She considered the dances that she saw as a girl to be superficial, and turned to the East for ideas about dance as a spiritual art. She choreographed and performed in *Radha* (1906), a dance about a Hindu goddess. She also composed and danced in the Japanese ballet *O-Mika* (1913) and in other adaptations of Asian material.

In 1915, she and her husband, Ted Shawn, opened the Denishawn school in Los Angeles and formed the Denishawn dance company. Their students included Martha Graham, Doris Humphrey, and Charles Weidman. The company toured the United States from 1915 to 1931. St. Denis devoted much of her later life to composing religious dances staged in churches. Katy Matheson

See also **Dance** (Modern dance); **Shawn, Ted.**

Saint Elias Mountains are a rugged series of the world's highest coastal mountains. They stand along the southeastern boundary of Alaska and the Yukon Territory. The range is nearly 300 miles (480 kilometers) long. It has a maximum width of about 90 miles (140 kilometers), excluding the coastal plain and foothill belt. The international boundary is 30 miles (48 kilometers) from the coast between Mount St. Elias and Mount Fairweather (see **Alaska** [physical map]).

The second and fourth highest peaks in North America stand in the Saint Elias Mountains. They are Mount Logan (19,524 feet, or 5,951 meters) in the Yukon Territory, and Mount St. Elias (18,008 feet, or 5,489 meters) in Alaska. Twelve other peaks in the range, including Mounts Vancouver, Fairweather, and Hubbard, are higher than any other U.S. peaks outside Alaska.

The ruggedness of the range prevents extensive exploration. Many peaks are unnamed. The mountains are composed chiefly of sedimentary and volcanic rocks of the Paleozoic and Mesozoic ages (see **Earth** [table: Outline of the earth's history]). The range has frequent rains. Glaciers can be found throughout the mountain area. The largest glacier, called Malaspina, is larger than the state of Rhode Island. Claus-M. Naske

See also **Alaska** (Land regions).

Saint Elmo's fire is the glow that accompanies a steady electrical discharge from certain objects. It occurs during thunderstorms or at other times when electrified clouds are present, and it is visible only in complete darkness.

In the past, St. Elmo's fire was commonly seen around the masts of sailing ships. Today, people sometimes see it around the propellers and wing tips of airplanes that are flying through electrified clouds. A few people have reported observing St. Elmo's fire around the horns of cattle. The name *Elmo* is a form of *Erasmus.* Saint Erasmus was considered the patron saint of Mediterranean sailors. Martin A. Uman

See also **Jack-o'-lantern.**

Saint-Exupéry, *san tehg zoo pay REE,* **Antoine de,** *ahn TWAHN duh* (1900-1944), a French aviator, created the literature of aviation in France. However, he is probably best known for his fantasy, *The Little Prince* (1943). In the story, a young prince from a distant planet tells the author of his experiences as he wandered among the planets seeking wisdom. *The Little Prince,* like Saint-Exupéry's other major writings, reflects his regard for human values and his opposition to all abuses of the human spirit.

Saint-Exupéry was born on June 29, 1900, in Lyon. He served in the French Army Air Force from 1921 to 1923. In 1926, he became a commercial pilot, flying from France to west Africa and in South America. He based his first books, the novels *Southern Mail* (1928) and *Night Flight* (1931), on these early flights. *Wind, Sand and Stars* (1939) is a collection of philosophical essays on the risks and rewards of flying.

During World War II (1939-1945), Saint-Exupéry flew dangerous reconnaissance missions. *Flight to Arras* (1942) is an account of one such wartime assignment. His *Wartime Writings: 1939-1944* was published in 1986. In 1944, Saint-Exupéry disappeared on a photographic mission. Catharine Savage Brosman

Saint-Gaudens, *saynt GAWD uhnz,* **Augustus** (1848-1907), was a famous American sculptor. His works include public monuments, portraits, and symbolic figures. Saint-Gaudens created sculptures in a simple, naturalistic style, reducing details to express the essential character of the subject.

Saint-Gaudens's first major triumph was a vigorous, heroic bronze statue for the Admiral David Farragut monument (1881) in Madison Square Park in New York City. The *Shaw Memorial* (1897) in Boston Common honors the commander of a black Civil War regiment. Saint-Gaudens created standing and seated statues of Abraham Lincoln for Chicago parks in 1887 and 1906. His *General William Tecumseh Sherman* on horseback (1903) stands at the entrance to Central Park in New York City. The moving, hooded figure of the *Adams Memorial*

Simon Benepe, City of New York Parks and Recreation

A Saint-Gaudens statue of General William Tecumseh Sherman stands at the entrance to Central Park in New York City.

(1891) expresses sadness and resignation to death. It is in Rock Creek Cemetery in Washington, D.C.

Saint-Gaudens was born in Dublin, Ireland, but grew up in New York City. At the age of 13, he was apprenticed to a cameo cutter. He studied at the National Academy in New York City, the École des Beaux-Arts in Paris, and in Rome. George Gurney

Saint George Island. See Pribilof Islands.

Saint George's (pop. 7,500) is the capital, chief port, and commercial and administrative center of Grenada, an island nation in the Windward Islands of the West Indies. The city lies on a picturesque harbor along the southwest coast of Grenada. See Grenada (map).

In 1650, the French founded a settlement near what is now St. George's. The town was moved to its present site in 1705. Britain gained control of Grenada in 1783, and St. George's later became the center of government of all the Windward Islands. Grenada gained independence from Britain on Feb. 7, 1974, and St. George's became the capital. Tourism is one of the city's main industries. Gerald R. Showalter

Saint-Germain, *san zhuhr MAN,* **Treaty of,** was signed by the Allied powers and the Republic of Austria on Sept. 10, 1919, after the defeat of Austria-Hungary in World War I (1914-1918). Austria-Hungary had made itself a republic in November 1918 after many of its regions declared their independence. The Allies held the new republic accountable in the treaty, which confirmed the breakup of Austrian power. Romania and the country later called Yugoslavia objected to treaty guarantees given to minority groups and delayed signing for several months. The Austrian National Assembly ratified the treaty on Oct. 17, 1919, and the agreement went into force on July 16, 1920. The United States, which signed the treaty but never ratified it, made a separate peace with Austria on Aug. 24, 1921.

Part I of the Treaty of St.-Germain provided that Austria could be admitted to the League of Nations, a forerunner to the United Nations, after a period of good behavior. Part II reduced Austria's territory from about 115,000 square miles (297,800 square kilometers) to only 32,369 square miles (83,835 square kilometers). The population was thereby reduced from 30 million to 6 million. Eight clauses guaranteed the independence and safety of Austria's minority groups.

The treaty forced Austria to recognize the independence of Poland, Czechoslovakia, Hungary, and the country later called Yugoslavia. These nations, together with Italy, also gained much territory that Austria had controlled before the war. Military clauses reduced the Austrian army to 30,000 soldiers and the navy to only four patrol boats. Only one factory could manufacture arms. One of the important clauses of the treaty forbade the union of Austria and Germany, which Austria had sought. But in 1938, the German dictator Adolf Hitler forced a union with Austria. In 1939, World War II began and set aside the treaty. Diane Shaver Clemens

Saint Gotthard Pass, *GAHT uhrd,* is a famous mountain pass in the Alps in south-central Switzerland. It is a level depression, surrounded by a number of small lakes. The Rhine, Rhône, and Ticino rivers begin near the pass. For location, see Switzerland (terrain map). A road with many hairpin turns crosses the pass at 6,916 feet (2,108 meters) above sea level. The rich farming and industrial valley of the Po River in northern Italy lies south of the pass.

The pass became an important trade route in the 1200's. The League of Three Cantons, the first three "states" of early Switzerland, guarded approaches to the pass during these early years. A hospice was founded in St. Gotthard Pass in the 1300's to give aid to travelers. Herbert H. Einstein

Saint Gotthard tunnels, *GAHT uhrd,* are two tunnels—one a highway tunnel and the other a railroad tunnel—that run through the Alps in south-central Switzerland. The highway tunnel, called the St. Gotthard Road Tunnel, is the world's longest automobile tunnel. It is 10.1 miles (16.3 kilometers) long. The railroad tunnel is 9.3 miles (15 kilometers) long.

The tunnels run nearly parallel to each other about 4,000 feet (1,200 meters) above sea level. They provide an easy crossing of the central Alps on the route between Switzerland and northern Italy. For location, see Switzerland (political map). The railroad tunnel was built between 1872 and 1882. The automobile tunnel was completed in 1980. Herbert H. Einstein

Saint Helena, *huh LEE nuh,* is a British island in the Atlantic Ocean. It lies about 1,200 miles (1,930 kilometers) off the southwest coast of Africa, and about 700 miles (1,100 kilometers) southeast of Ascension Island, which is the nearest land (see Atlantic Ocean [map]). St. Helena is famous because Napoleon Bonaparte was forced to live there from 1815 until his death in 1821 (see Napoleon I).

The Portuguese discovered St. Helena in 1502, but it has belonged to Britain since 1673. It serves as the administrative center for certain other British islands in the southern part of the Atlantic Ocean. These include Ascension Island and the Tristan da Cunha group, which consists of Tristan da Cunha, Gough, Inaccessible, and Nightingale islands.

Richard Harrington, FPG

Napoleon's home on St. Helena is near Jamestown. From 1815 to 1821, Napoleon lived in exile in the home, called Longwood.

St. Helena is rough and mountainous. It covers 47 square miles (122 square kilometers) of lonely, volcanic wasteland. Barren cliffs rise 1,000 feet (300 meters) above sea level. The only village and port is Jamestown, the island capital. It lies at the mouth of a small mountain stream near James Bay. St. Helena has a population of about 7,000. The people are Europeans, East Indians, and Africans.

Less than a third of St. Helena can be used for raising crops. The chief crop is New Zealand flax. Grasslands where cattle and sheep graze cover part of the island. The government has helped set up factories to make fiber mats. Other industries include fish curing and lacemaking. Hartmut S. Walter

See also Ascension.

Saint Helens, Mount. See Mount Saint Helens.

Saint James's Palace is a royal mansion in London, England. It stands in Westminster, north of the Mall (see **London** [map of central London]). The palace served as the official London residence of the British sovereign until 1837. At that time, Queen Victoria moved the royal residence to Buckingham Palace. The British court is still officially known as "The Court of St. James's." Henry VIII built the palace in 1532.

Saint John (pop. 69,661; met. area pop. 122,678) is the largest city and leading industrial center of New Brunswick. It also ranks as a major Canadian port. St. John Harbor remains open all winter, when ice closes Canada's inland ports. The city lies on the Bay of Fundy, at the mouth of the St. John River. For location, see **New Brunswick** (political map).

Saint John is called the *Loyalist City* because it was founded by Americans known as United Empire Loyalists. These people moved to Canada because of their support for Britain during the Revolutionary War in America. In 1783, about 4,000 of them sailed from New England to the site of Saint John, where they had been granted land because of their loyalty to Britain. In 1785, the Loyalist communities of Parrtown and Carleton merged to form Saint John, which then became the first incorporated city in Canada. The city was named for the St. John River. The French explorer Samuel de Champlain had named the river in honor of Saint John the Baptist. Champlain reached the waterway on the saint's feast day, June 24, in 1604.

Description. Saint John covers 122 square miles (316 square kilometers). Its metropolitan area covers 1,297 square miles (3,360 square kilometers). Much of the city lies on peninsulas. Saint John is the home of the New Brunswick Museum, the oldest museum in Canada. This museum was established in 1842. Saint John also has a branch campus of the University of New Brunswick.

The city's most famous tourist attraction is the Reversing Falls, at the mouth of the St. John River. Here, high tides from the Bay of Fundy force the river backwards through the falls twice a day. Historic attractions in Saint John include the Martello Tower, a stone fortification built during the War of 1812; the Loyalist House, a home completed in 1817; and the City Market building, which opened in 1876.

Saint John has about 80 manufacturing plants, which employ about a seventh of the city's workers. The main industries include oil refining, pulp and paper manufacturing, shipbuilding, and sugar refining. In addition, the city is a busy port. An offshore terminal nearby serves huge oil tankers. Two railroads provide freight and passenger service for the city. Airlines use Saint John Airport.

Government and history. Saint John has a council-manager form of government. The voters elect a mayor and the 12 council members to three-year terms. An appointed city manager serves as the chief administrative official of the city government.

Maliseet Indians lived in what is now the Saint John area before Europeans arrived. By 1631, French fur traders had built a fort there. Rival French traders and the British fought over the area. The British finally won control in 1755.

The area remained largely a wilderness until the United Empire Loyalists arrived in 1783. Many of the early residents built or operated wooden sailing ships. By the mid-1800's, Saint John had one of the world's largest merchant fleets. In the late 1800's, the increasing use of iron steamships led to the decline of Saint John's sailing-ship industry. The Great Fire of 1877 destroyed much of the city, but the people quickly rebuilt it. By 1900, Saint John had about 40,000 people.

The 1960's brought a new period of growth to Saint John. Corporations established or expanded many large facilities, including an oil refinery, paper mills, ship terminals, and shipyards. In 1969, the city's population jumped from 51,567 to 89,039 when Saint John merged with the city and the parish of Simonds.

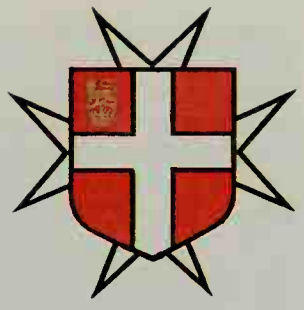
In 1974, the city began a downtown reconstruction program. The program focused on the development of Brunswick Square, a shopping center, hotel, and office complex. Brunswick Square was completed in 1981. In 1983, Market Square opened nearby. Market Square is a shopping, dining, and convention center. An adjoining hotel on the waterfront was completed in 1984. Other improvements included placing wiring underground, planting trees, and paving streets with red brick.

Fred Hazel

For the monthly weather in Saint John, see **New Brunswick** (Climate). See also **New Brunswick** (pictures).

Saint John, Order of, is a nondenominational Christian order devoted to the relief of human suffering. It provides services to people of all races, religions, and social classes. The order's full name is The Most Venera-

ble Order of the Hospital of St. John of Jerusalem. Membership in the order is an honor granted with the approval of the queen of England. The order operates mainly through two foundations—the St. John Ambulance and the St. John Ophthalmic Hospital.



Museum and Library of the Order of St. John

Coat of arms of the Order of St. John

The St. John Ambulance is made up of over 250,000 unpaid volunteers who are trained to give first aid at public gatherings. It treats more than 1 million people in over 40 countries. It also holds classes for the public in first aid and related subjects. The St. John Ophthalmic Hospital, an eye treatment center in Jerusalem, is supported by voluntary donations. It operates mobile units to treat people in remote parts of the Middle East.

The Order of St. John stems from a medieval order, the Knights Hospitallers (see **Knights Hospitallers**). The present order was established in Britain by royal charter in 1888. Headquarters are in London.

Critically reviewed by the Order of St. John

Saint John River is the main waterway of New Brunswick, Canada. It is 390 miles (628 kilometers) long and drains more than 21,500 square miles (55,680 square kilometers). The St. John is formed by several small streams that rise on or near the boundary between Quebec and Maine. The river flows northeast to cross the northwest corner of Maine, then forms the boundary between Maine and New Brunswick. After entering New Brunswick, the river continues south for over 200 miles (320 kilometers) and empties into the Bay of Fundy.

The St. John, often called the *Rhine of America,* is one of the most beautiful rivers in the Atlantic Provinces. Three miles (5 kilometers) after it enters New Brunswick, it plunges over Grand Falls, a drop of 75 feet (23 meters). It drops the same distance in the rapids that extend for nearly 1 mile (1.6 kilometers) below the falls. Small boats can travel about 260 miles (418 kilometers) up the St. John. Near its mouth are the Reversing Falls of Saint John (see **Reversing Falls of Saint John**). T. W. Acheson

Saint John's (pop. 99,182; met. area pop. 172,918), is the capital and largest city of Newfoundland and Labrador. St. John's serves as the province's commercial, cultural, and educational center. It lies on a well-sheltered harbor near a rich fishing area called the Grand Banks. For location, see **Newfoundland and Labrador** (political map). This location has made the city a busy port where ships of many countries dock to make repairs, take on supplies, and shelter from storms. St. John's has been called the "service station of the North Atlantic."

The explorer John Cabot may have been one of the first Europeans to visit the area that is now St. John's. Historians believe he entered the harbor in 1497. They also believe Cabot named the site for Saint John the Baptist because he arrived there on the saint's feast day, June 24. St. John's ranks as one of the oldest inhabited areas in North America.

St. John's lies closer to Europe than any other major North American city. As a result, it has played a part in several historic events. In 1901, for example, the Italian inventor Guglielmo Marconi received the first transatlantic wireless signal on Signal Hill in St. John's. In 1919, the British fliers John Alcock and Arthur Whitten Brown took off from St. John's on the first successful nonstop flight across the Atlantic.

Description. St. John's covers 172 square miles (446 square kilometers) on the Avalon Peninsula at the southeastern end of the island of Newfoundland. The metropolitan area extends over 311 square miles (805 square kilometers). Most of the downtown area and other older parts of the city lie on hills that slope up from the waterfront. The city's landmarks include Cabot Tower; the

© Bob Burch, West Stock

St. John's lies on a deep, well-sheltered harbor, where fishing boats stop for repairs and supplies.

Confederation Building, which houses the provincial legislature; the Memorial University of Newfoundland; and the Roman Catholic *basilica* (cathedral).

The Provincial Museum of Newfoundland and Labrador features historical and cultural exhibits on the province. The Arts and Culture Centre has an art gallery and a theater. Signal Hill offers a spectacular view of the city, the harbor, and the Atlantic coast. The annual rowing race called the St. John's Regatta is the oldest organized sporting event in North America, dating from 1818.

Economy. Many people in St. John's work for the federal, provincial, or local government. Other important economic activities include fishing and ship servicing and repair. The St. John's Airport is located within the city. St. John's is the eastern starting point of the Trans-Canada Highway, which extends across the country.

Government and history. St. John's has a mayor-council form of government. The voters elect the mayor and 10 council members to four-year terms.

Beothuk Indians probably lived on the Avalon Peninsula before Europeans arrived. John Cabot, an Italian explorer in England's service, claimed the area for England in 1497. European fishing crews set up small fishing villages there in the early 1500's. The explorer Sir Humphrey Gilbert reached the area in 1583 and renewed England's claim to it. The Dutch attacked St. John's in 1665, and the French captured it in 1696, 1708, and 1762. But the English recaptured the settlement each time.

During the Revolutionary War in America (1775-1783) and the War of 1812, the British made St. John's a major naval base. In the 1800's, the settlement became a center for sailmaking, shipbuilding, and drying and smoking fish. St. John's had a population of about 30,000 when it was incorporated as a city in 1902. During World War II (1939-1945), both Canada and the United States had major military bases in the area. These bases brought new jobs and thousands of people to St. John's.

What is now Newfoundland and Labrador became a province in 1949, with St. John's as its capital. By 1951, St. John's had a population of 53,000. After St. John's became a provincial capital, the federal and provincial governments established many agencies there. New buildings were erected to house these agencies. The Confederation Building opened in 1959, and a new City Hall opened in 1970.

In 1979, petroleum and natural gas were discovered in the Atlantic Ocean about 200 miles (322 kilometers) east of St. John's. The area, a section of the Grand Banks, is now called the Hibernia oil field. The discovery resulted in new economic activity in St. John's related to the servicing of the oil exploration industry. Oil production began in late 1997. William R. Callahan

For St. John's monthly weather, see **Newfoundland and Labrador** (Climate). See also **Newfoundland and Labrador** (pictures).

Saint-John's-wort, also called *hypericum,* is the name of a group of about 300 species of herbs and shrubs with large yellow flowers. Most St.-John's-worts grow in the temperate and warmer regions of the Northern Hemisphere. The plants are usually low shrubs. Some St.-John's-worts are evergreen. The flowers of these plants bloom in clusters in summer. Pink or purplish flowers are rare. St.-John's-worts grow well in loam or moist, sandy soil. Some grow well in shady locations. The larger St.-John's-worts form rounded bushes when grown alone. The smaller ones make good low borders or ground cover in gardens. The *goldflower* is a hybrid. Many people use extracts of St.-John's-wort as an antidepressant drug to relieve mild forms of depression. But scientists are not certain whether the herb can effectively treat mental illness. Fred T. Davies, Jr.

WORLD BOOK illustration by Christabel King

St.-John's-wort has colorful flowers and hardy greenery. Many people use this shrub as a border in gardens.

Scientific classification. The St.-John's-wort belongs to the St.-John's-wort family, Hypericaceae. The scientific name for the goldflower is *Hypericum moseranum.*

Saint Joseph (pop. 73,990; met. area pop. 102,490) is an agricultural trading center in northwestern Missouri. It lies on the east bank of the Missouri River, about 40 miles (64 kilometers) north of Kansas City. For location, see **Missouri** (political map).

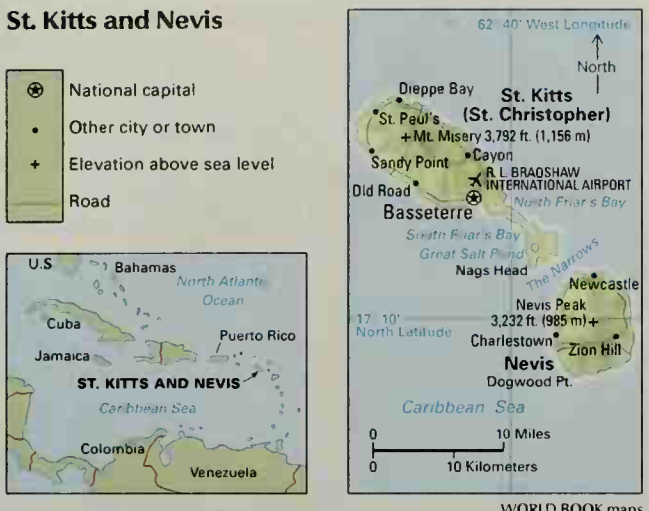
St. Joseph is a trading center for farm products from parts of Missouri, Kansas, Nebraska, and Iowa. The city's chief manufactured products include medicines for livestock and other animals and pet food. Missouri Western State College is in the city.

Landmarks include the 1859 Missouri Valley Trust Building and the 1879 Buchanan County Courthouse. The Patee House Museum was a pony express headquarters in 1860 and 1861 (see **Pony express**). The Jesse James House Museum is where the famous bank robber once lived and where he was killed in 1882.

Joseph Robidoux, a French fur trader, founded St. Joseph in 1826. In the 1840's and 1850's, settlers heading west used the city as a starting point. In the last half of the 1800's, the city's many wholesale companies and other businesses made it a center of trade for the western half of the county. In the late 1800's and early 1900's, the city was an important meat-packing center.

St. Joseph is the seat of Buchanan County. The city has a city-manager government. Patrick E. McLear

Saint Kitts and Nevis, *NEE vuhs* or *NEHV uhs,* is a country in the Caribbean Sea that consists of two islands. The islands are St. Kitts (sometimes called St. Christopher) and Nevis. The islands lie about 190 miles



WORLD BOOK maps

(310 kilometers) east of Puerto Rico. The country has a land area of 101 square miles (261 square kilometers). St. Kitts covers 65 square miles (168 square kilometers), and Nevis covers 36 square miles (93 square kilometers). St. Kitts and Nevis has a population of about 38,000. About 80 percent of the people live on St. Kitts.

St. Kitts and Nevis became an independent nation in 1983, after being controlled by Britain since 1713. Basseterre (pop. 14,725) is the country's capital and largest city. The East Caribbean dollar is the basic unit of currency. See **Flag** (Flags of the Americas).

Government. St. Kitts and Nevis is a constitutional monarchy and a member of the Commonwealth of Nations (see **Commonwealth of Nations**). A prime minister heads the government and carries out its operations with the aid of a Cabinet. A one-house parliament makes the country's laws. It consists of eight representatives from St. Kitts, three representatives from Nevis, and three senators. The people elect the representatives. The senators are appointed on the advice of the prime minister and the leader of the opposition political party. The head of the political party with the most seats in parliament usually serves as prime minister. Nevis has its own local legislature. It has the right to secede and become an independent country.

People. Almost all the people of St. Kitts and Nevis are descendants of black Africans. The people speak English, the official language. About two-thirds of the people live in rural villages scattered along the coasts. Most of the rural people work on small farms, sugar cane estates, or large coconut farms. Most of the rest of the people live in urban areas. Basseterre, on St. Kitts, is the chief urban center. Charlestown is the main urban center of Nevis. Most of the country's people live in wooden houses. They wear clothing similar to that worn in the United States and other Western nations. Children must attend school from the ages of 5 to 17.

Land and climate. The two islands lie about 2 miles (3.2 kilometers) apart. They are the tops of volcanic peaks that rise out of the Caribbean Sea. The peak that forms much of St. Kitts is called Mount Misery. It rises 3,792 feet (1,156 meters) above sea level. The peak of Nevis is 3,232 feet (985 meters) above sea level. Both islands have rolling landscapes with fertile, narrow plains along the coasts. Many of the beaches have black volcanic sand. The annual rainfall is about 55 inches (140 centimeters). The average temperature is 78 °F (25 °C).

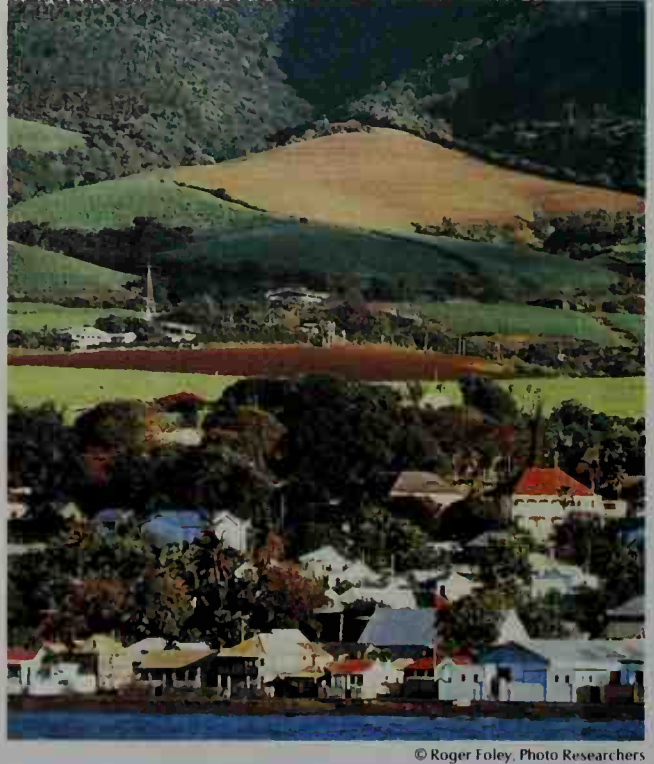
Economy. The economy of St. Kitts and Nevis is based on sugar and tourism. Sugar cane is raised on St. Kitts and is processed at a large government-owned sugar mill there. The fertile land of Nevis is divided into small farms that produce vegetables, fruits, and cotton. The principal manufactured goods of the country include clothing and footwear. The country's beaches, scenery, and warm sunny climate attract many tourists. Unemployment is high on both islands, especially during periods when tourism and sugar production are slow. The country's main trading partners are the United Kingdom, the United States, and Canada.

Both islands have bus service. St. Kitts has an international airport. Ferryboats and small planes carry people between the two islands.

History. Arawak Indians were the first inhabitants of the islands of St. Kitts and Nevis. They were followed by Carib Indians. Christopher Columbus sighted the islands in 1493 on his second voyage to the New World. In 1623, the British began settling on St. Kitts. French settlers soon followed. Nevis was first settled by the British in 1628. The European settlers brought African slaves to St. Kitts to work on sugar cane plantations.

Britain took complete control of St. Kitts in 1713. The British later ruled St. Kitts and Nevis, along with the island of Anguilla, as a single colony. In 1967, the colony became an associated state of Britain. Anguilla became a separate British dependency in 1980. St. Kitts and Nevis became an independent nation on Sept. 19, 1983. In August 1998, voters on Nevis narrowly defeated a referendum that would have given the island its independence from St. Kitts.

Gerald R. Showalter



© Roger Foley, Photo Researchers

Basseterre is the capital and chief urban center of St. Kitts and Nevis. About two-thirds of the country's people live in rural villages, and most of the rest live in urban areas.

Louis S. St. Laurent

Louis S. St. Laurent

Prime Minister of Canada
1948-1957

King 1935-1948 | **St. Laurent** 1948-1957 | **Diefenbaker** 1957-1963

Karsh, Ottawa

Saint Laurent, *san law RAHN,* **Louis Stephen** (1882-1973), served as prime minister of Canada from 1948 to 1957. He was the second French Canadian to hold the office. Like Sir Wilfrid Laurier, the first French-Canadian prime minister, St. Laurent was a Liberal.

Under St. Laurent's leadership, Canada took an increasingly important part in world affairs. St. Laurent was one of the chief architects of the North Atlantic Treaty Organization (NATO), a military alliance of Western nations. He also had a leading role in transforming the British Empire into the modern, multiracial Commonwealth of Nations. In Canada, he helped bring Newfoundland (now Newfoundland and Labrador) into the nation as the 10th province in 1949. But as a Canadian who was half Irish and half French, St. Laurent considered his outstanding contribution to be the promotion of greater understanding and cooperation between English- and French-speaking Canadians.

Louis St. Laurent entered politics unusually late in life. He was 59 years old when he was first elected to Parliament. St. Laurent then became minister of justice and later, at the age of 66, took office as prime minister. He had already earned a reputation as an outstanding lawyer. Many Canadians thought St. Laurent was too modest and reserved to be an effective politician. But he led the Liberals to victory with overwhelming majorities in 1949 and 1953.

A lean, quick-moving man, St. Laurent had a shy manner and a friendly smile. He had piercing black eyes, white hair, and a neat white mustache. St. Laurent spoke French and English equally well. When he used English, listeners could hear a trace of Irish brogue. St. Laurent's gestures, particularly an expressive hunch of the shoulders, were French.

Early life

Boyhood and education. Louis S. St. Laurent was born on Feb. 1, 1882, in the town of Compton, Quebec, a little north of the Canadian border with Vermont. He was one of the six children of Moïse St. Laurent, a storekeeper, and Ann Mary Broderick St. Laurent, a former schoolteacher. His father was descended from early French settlers. His mother's parents were Irish immigrants. Louis grew up learning to speak French with his father and English with his mother.

As a boy, Louis became keenly interested in politics. His political hero was Wilfrid Laurier. During the 1896 election, the wall telephone in his father's store was the town's only source of election news. Louis enthusiastically relayed bulletins as they brought the news that Laurier and the Liberals had won.

During the 1900 election, Louis was in college. He could not leave his dormitory after a certain hour, so he lowered a pail from his window and hauled up election bulletins. In 1903, while studying law, St. Laurent reported Quebec politics for the *Sherbrooke Record.* He took the job so he could watch the Quebec parliament in action from the press gallery.

St. Laurent attended St. Charles Seminary in Sherbrooke, Quebec, and received a bachelor's degree in 1902. He then studied law at Laval University in Quebec and earned his law degree in 1905. St. Laurent refused the offer of a Rhodes Scholarship to Oxford University because he wanted to begin practicing law immediately. He went to work in a Quebec law office for a salary of $50 a month.

Marriage. In May 1908, St. Laurent married Jeanne Renault (1886-1966), the daughter of a Beauceville East, Quebec, businessman. She later recalled: "As soon as I saw Louis, I said to myself, 'That's the man I'm going to marry.'" The St. Laurents had two sons and three daughters. Both sons became lawyers. One of them, Jean Paul, served in Parliament from 1955 to 1958.

Lawyer. St. Laurent quickly earned a reputation as a brilliant lawyer. In 1914, he became a professor of law at Laval University. He served as president of the Canadian Bar Association from 1930 to 1932 and ranked as one of the top Canadian authorities on constitutional law. From 1937 to 1939, he served as senior counsel for the Royal Commission on federalism.

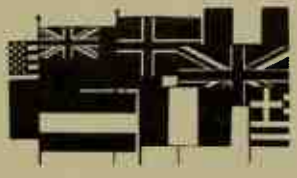
Entry into public life

In November 1941, Minister of Justice Ernest Lapointe died. He had been the principal voice of French-

Important events during St. Laurent's administration

Newfoundland (now Newfoundland and Labrador) became Canada's 10th province during St. Laurent's administration, on March 31, 1949.

WORLD BOOK map



NATO was set up in 1949 with Canada as a member. St. Laurent helped form the military alliance of Western countries.

The Supreme Court of Canada became the final court of appeals for Canadians in 1949, during St. Laurent's administration.

WORLD BOOK illustrations by Tak Murakami

Canadians in the government. Prime Minister Mackenzie King asked the 59-year-old St. Laurent to succeed Lapointe. St. Laurent took office as minister of justice on Dec. 10, 1941.

St. Laurent served as minister of justice during World War II and encouraged unity between English- and French-Canadians by supporting *conscription* (drafting men for military service). During World War I, English-Canadians had favored conscription but French-Canadians had hotly opposed it (see **Borden, Sir Robert Laird** [Conscription crisis]). In February 1942, St. Laurent won election to Lapointe's old Parliament seat from Quebec East. He was reelected in 1945. After World War II ended in 1945, St. Laurent wanted to return to private life. But King persuaded him to stay in office.

On Sept. 4, 1946, King named St. Laurent minister of external affairs. In 1946 and 1947, St. Laurent led the Canadian delegations to the initial sessions of the UN General Assembly in London and New York City.

In 1948, King announced his plans to retire. He urged the Liberal Party to elect St. Laurent as his successor. On Aug. 7, 1948, St. Laurent was elected leader of the Liberal Party.

Important dates in St. Laurent's life

1882 (Feb. 1) Born in Compton, Quebec.
1908 (May 19) Married Jeanne Renault.
1930 Elected president of Canadian Bar Association.
1941 (Dec. 10) Became minister of justice.
1942 Elected to Parliament.
1946 (Sept. 4) Appointed minister of external affairs.
1948 (Aug. 7) Elected leader of Liberal Party.
1948 (Nov. 15) Became prime minister of Canada.
1949 The United Kingdom gave Canada the power to amend its own constitution.
Newfoundland (now Newfoundland and Labrador) became Canada's 10th province.
1957 (June 21) Resigned as prime minister.
1958 (January) Resigned as Liberal Party leader.
1973 (July 25) Died in Quebec City.

Prime minister (1948-1957)

Louis St. Laurent took office as prime minister on Nov. 15, 1948. During his term, Canada's international reputation soared. St. Laurent realized that Canada would have to adopt a more international outlook than ever before. He and his minister of external affairs, Lester B. Pearson, led the efforts in forming the North Atlantic Treaty Organization.

In 1949, the United Kingdom granted the Canadian Parliament the power to amend Canada's constitution in matters pertaining to the federal government. Previously, only the British Parliament had been authorized to amend the Canadian constitution. Newfoundland became Canada's 10th province in 1949. Also in 1949, the Supreme Court of Canada became the final court of appeals for Canadians. Until this time, Canadian legal appeals had gone to the Privy Council in England.

In 1952, upon St. Laurent's recommendation, Vincent Massey became the first Canadian-born governor general of Canada (see **Massey, Vincent**). St. Laurent explained his choice: "I would not like to think that a Canadian, alone of the Queen's subjects, would not be considered to represent the Queen in Canada."

After being in power for 22 years, the Liberals lost the election of June 1957. They won only 105 seats in Parliament, compared to 112 for the Progressive Conservatives and 44 for other parties. The Progressive Conservatives took over the government and John G. Diefenbaker became prime minister. The defeat of the Liberals resulted partly from a desire for change and partly from a rising new national spirit in Canada, which the energetic Diefenbaker seemed to represent.

St. Laurent was reelected to Parliament. But he did not seek reelection after Parliament was dissolved on Feb. 1, 1958. St. Laurent retired as party leader in January 1958, and Pearson succeeded him.

Retirement and death

In 1958, St. Laurent returned to the practice of law in Quebec. He also lectured on law at Laval University and served on the boards of several large Canadian corporations. St. Laurent did not withdraw completely from political life. He continued to speak publicly on behalf of the Liberal Party. St. Laurent was largely confined to his home in Quebec City after breaking a hip in 1968. He died on July 25, 1973. St. Laurent was buried in Compton.

Jacques Monet

Related articles in *World Book* include:

Canada, Government of
Canada, History of
Diefenbaker, John George
King, William Lyon Mackenzie
Laurier, Sir Wilfrid
Pearson, Lester Bowles
Political party (Political parties in Canada)
Prime minister of Canada

Saint Laurent, *san law RAHN,* **Yves,** *eev* (1936-), became perhaps the most influential fashion designer of the late 1900's. In 1957, at the age of 21, Saint Laurent was appointed head designer of the famous Dior fash-

ion house in Paris. Saint Laurent's designs are noted for their superb sense of line, rich color, and exceptional craftsmanship. He has made innovations in his adaptation of the comfort, wearability, and lively spirit of everyday fashion to *haute couture* (high fashion).

Saint Laurent was born on Aug. 1, 1936, in Oran, Algeria. In 1958, at the house of Dior, the young designer created the *trapeze,* a loose, unbelted dress that flared from the shoulders to the hem.

In 1961, Saint Laurent opened his own fashion house in Paris. The firm has probably had more impact on fashion design and merchandising than any other fashion house of its time. In 1966, Saint Laurent introduced a woman's evening pants suit that was tailored like a man's tuxedo. Also in 1966, he opened his first ready-to-wear boutique called Rive Gauche. He presented one of his most famous collections in 1976. The collection won praise for its elegant and luxurious fabrics and colorful adaptation of Russian peasant costumes to high fashion. Saint Laurent has also designed for the theater.

In 1999, Saint Laurent transferred control of his business to Gucci, an Italian fashion house, but retained control of his haute couture line. In 2002, he announced his retirement and closed the haute couture line.

Jean L. Druesedow

Saint Lawrence, Gulf of. See Gulf of Saint Lawrence.

Saint Lawrence River is one of the most important rivers of North America. The St. Lawrence flows about 800 miles (1,300 kilometers) from its headwaters at Lake Ontario to its mouth in the Gulf of St. Lawrence. It drains an area of approximately 498,500 square miles (1,291,100 square kilometers), including most of southeastern Canada.

The St. Lawrence River links the Atlantic Ocean with the Great Lakes by means of the St. Lawrence Seaway (see **Saint Lawrence Seaway**). The river and the seaway help make the ports on the Great Lakes some of the busiest in the world. The St. Lawrence River served as the first highway of the explorers, fur traders, and colonists who came to Canada and the United States hundreds of years ago. It is often called the *Mother of Canada.*

The course of the St. Lawrence. The St. Lawrence River and the waterways that flow into it make up the St. Lawrence River system. The source of this system is the St. Louis River, which enters Lake Superior at Duluth, Minn. The system includes Lakes Superior, Michigan, Huron, Erie, and Ontario and the rivers that connect them. It extends about 2,280 miles (3,669 kilometers) from its source to the Gulf of St. Lawrence. The St. Lawrence River itself begins at the northeast end of Lake Ontario and flows northeast. Like most rivers, the St. Lawrence River has an upper, middle, and lower part.

The upper St. Lawrence flows from Lake Ontario to Montreal, Quebec. The first two-thirds of the upper part of the river form the boundary between Canada and the United States. All the rest of the St. Lawrence lies entirely within Canada and flows chiefly through the province of Quebec. The Thousand Islands, a group of more than 1,700 islands, lie within a 40-mile (64-kilometer) section of the river as it leaves Lake Ontario. The upper river's chief tributary, the Ottawa River, flows into the St. Lawrence just west of Montreal.

Most of the upper St. Lawrence has an average width of 1 $\frac{1}{4}$ miles (2 kilometers). But the river broadens in some places to form such "lakes" as Lake St. Francis and Lake St. Louis. The upper St. Lawrence has about 30 miles (48 kilometers) of rapids. It falls from 243 feet (74 meters) above sea level at Lake Ontario to 20 feet (6 meters) above sea level at Montreal.

The middle St. Lawrence extends from Montreal to Quebec City, Quebec, and is about as wide as the upper river. It includes one "lake," Lac St.-Pierre.

The lower St. Lawrence is about 10 miles (16 kilometers) wide near Quebec City. It broadens to 90 miles (145

St. Lawrence River

The St. Lawrence is the third longest river in Canada. Only the Mackenzie and Peace rivers are longer. The St. Lawrence flows about 800 miles (1,300 kilometers) from the northeast end of Lake Ontario to the Gulf of St. Lawrence. The river connects the Atlantic Ocean and the Great Lakes.

kilometers) at its mouth at the western tip of Anticosti Island in the Gulf of St. Lawrence. Every second, the river empties about 400,000 cubic feet (11,000 cubic meters) of water into the gulf. The gulf is a deep arm of the Atlantic Ocean, and the tides of the ocean affect the river as far west as Trois-Rivières, Que. The tides may raise the level of the river as much as 19 feet (5.8 meters). East of Trois-Rivières, the ocean changes the water of the river from fresh to salty.

Commerce. The St. Lawrence carries more freight than any other river of Canada—over 60 million short tons (54 million metric tons) annually. About 40 percent of this cargo moves between North America and countries overseas.

The freight carried on the St. Lawrence consists chiefly of *bulk cargo.* Such cargo includes grain, iron ore, and other goods that are stored loose in the holds of ships called *dry bulk carriers.* These ships carry iron ore from western Labrador in Quebec to the steel mills of Chicago, Cleveland, and other ports on the Great Lakes. The ships return with grain from lake ports. Iron ore accounts for about half the freight traffic up the river, and wheat and other grains make up about three-fourths of the downriver freight.

The lower St. Lawrence is more than 100 feet (30 meters) deep, but the river becomes much shallower upstream. Until 1959, parts of the upper St. Lawrence were too shallow for large ships to pass through. That year, the United States and Canada completed the St. Lawrence Seaway, which provided a navigation channel 27 feet (8 meters) deep. The seaway enabled most oceangoing vessels to sail between the Atlantic Ocean and such Great Lakes ports as Toronto; Thunder Bay, Ont.; Detroit; and Milwaukee. The project also included construction of a hydroelectric power dam on the river near Cornwall, Ont.

Animal and plant life. The St. Lawrence and its valley are the home of many kinds of animals and plants. Fishes of the river include bass, eels, perch, pike, smelts, and trout. Forests of birch, elm, hemlock, maple, oak, and spruce trees grow along the river's shores. The woods provide shelter for bears, deer, foxes, moose, muskrats, opossums, rabbits, raccoons, skunks, and squirrels. Such waterfowl as ducks, geese, gulls, and loons build their nests near the river.

Pollution from factories, sewage, and ship wastes is the greatest threat to the river's wildlife. Canada and the United States have taken steps to control this pollution.

History. The channel of the St. Lawrence was formed by the same glacier that carved out the Great Lakes. The glacier melted from 11,000 to 15,000 years ago, toward the end of the Pleistocene Ice Age. The resulting water created the lakes and the river.

Algonquin and Iroquois Indians lived along the St. Lawrence before Europeans arrived. The French explorer Jacques Cartier led an expedition up the river in 1535. On August 10, the feast day of Saint Lawrence, Cartier entered a bay that he named the Gulf of St. Lawrence. From there he sailed to what is now Montreal, where he was stopped by rapids. Cartier called the river the River of Canada, but it became known as the St. Lawrence about 100 years later.

During the 1600's, the French established settlements at Quebec City, Trois-Rivières, Montreal, and other points along the river. Many of these settlements became fur-trading centers and busy ports. The St. Lawrence also became part of a route to settlements in what is now the United States.

Britain won control of almost all French lands in Canada in 1763. The St. Lawrence then became a main transportation route for the huge cargoes of furs, timber, wheat, and other Canadian exports shipped to Britain.

Various attempts were made to improve navigation on the St. Lawrence River. In 1680, construction of a canal was begun to enable traders and trappers to bypass the rapids near Montreal. Other canals were added through the years, and work on the St. Lawrence Seaway began in 1954. Each year, the upper St. Lawrence freezes for the winter. Canada and the United States are seeking ways to keep the river open the year around without harming the environment. Carman Miller

Related articles in *World Book* include:
Cartier, Jacques
Great Lakes
Gulf of Saint Lawrence
Ontario (picture: Thousand Islands)
Thousand Islands

Saint Lawrence Seaway is a major commercial waterway that links the Atlantic Ocean and the Great Lakes. The seaway is formed by the St. Lawrence River, several lakes, and a system of canals and locks. It includes a hydroelectric power project that supplies electricity to parts of Ontario and of New York.

The St. Lawrence Seaway handles about 50 million short tons (45 million metric tons) of cargo annually. Most of the freight travels from Canada and the United States to countries in Europe. The freight consists mainly of *bulk cargo,* such as grain, minerals, and other raw products. The seaway is the cheapest shipping route for large quantities of these products. Iron ore and grains, which are bulk cargoes, make up about 65 percent of the tonnage. Other freight carried on the seaway includes coal, oil, and *general cargo,* which consists of such manufactured products as automobiles and steel.

Canadian ships carry about 65 percent of the seaway trade. The United States and other nations transport the rest.

The Atlantic Ocean and the Great Lakes have different elevations, but canals and locks enable ships to navigate the seaway. Most of the canals and locks are on the St. Lawrence River between Montreal and Lake Ontario.

WORLD BOOK map

The St. Lawrence Seaway lies in Canada and the United States. The two nations developed it to provide large ships with a water route linking the Great Lakes and the Atlantic Ocean.

The rest form the Welland Ship Canal, which connects Lakes Ontario and Erie. Lake Ontario, the lowest of the Great Lakes, is more than 200 feet (61 meters) higher than the ocean.

Canada and the United States began to build the St. Lawrence Seaway in 1954 and completed it in 1959. Each nation built and operates its own section of the waterway. The seaway plays an important part in the economies of both countries.

The seaway system

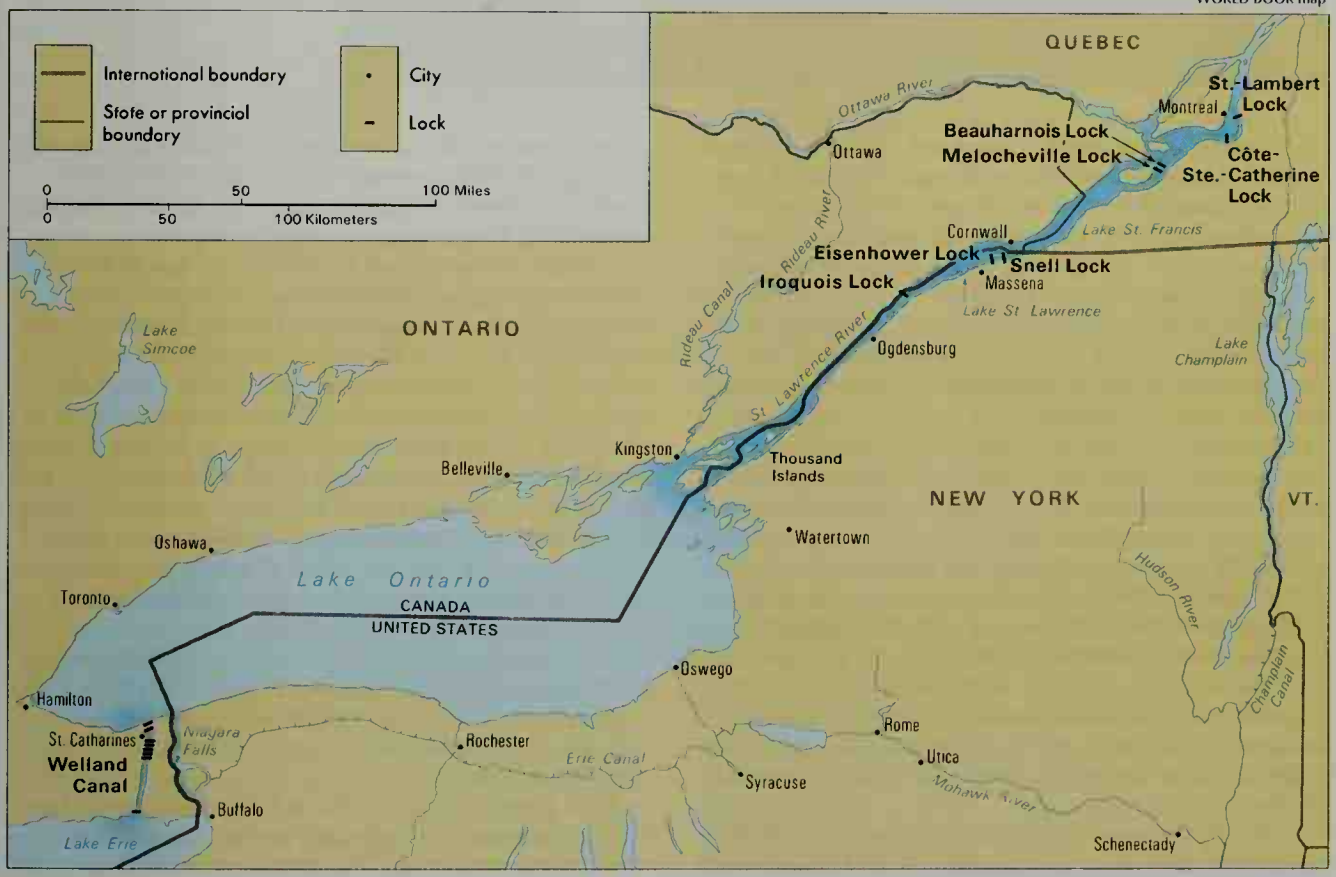
The St. Lawrence Seaway extends about 450 miles (724 kilometers) from the eastern end of Lake Erie to Montreal. Major Canadian ports served by the waterway include Montreal, Toronto, Hamilton, and Thunder Bay. Among the chief U.S. ports that handle seaway shipping are Buffalo, Cleveland, Detroit, Chicago, and Duluth.

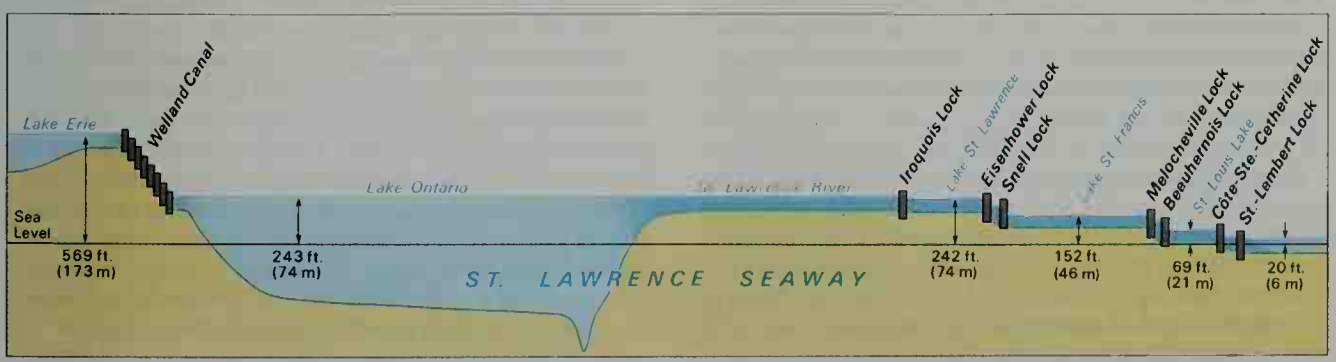
The seaway includes about 65 miles (105 kilometers) of canals, plus 15 locks and 3 dams. The dams hold back part of the St. Lawrence River and so form a reservoir called Lake St. Lawrence. The seaway's hydroelectric power project uses water from Lake St. Lawrence to generate electricity. The other lakes along the route of the seaway are broad areas of the St. Lawrence River.

Canals and locks of the waterway are operated by the St. Lawrence Seaway Authority in Canada, and by the St. Lawrence Seaway Development Corporation in the United States. The Canadian agency administers about

St. Lawrence Seaway The seaway extends from the eastern end of Lake Erie to Montreal. The Welland Ship Canal, which by-passes Niagara Falls, is part of the seaway. The seaway also includes several locks on the St. Lawrence River between the Thousand Islands and Montreal.

WORLD BOOK map





A profile of the St. Lawrence Seaway shows how the locks help ships overcome varying water levels. A ship sailing the seaway moves from 569 feet (173 meters) above sea level in the eastern part of Lake Erie to 20 feet (6 meters) above sea level in the St.-Lambert Lock.

St. Lawrence Seaway Development Corporation

Two locks of the St. Lawrence Seaway are operated by the United States. Both of them—the Eisenhower Lock, *left,* and the Snell Lock—are near Massena, N.Y.

55 miles (89 kilometers) of canals and 13 locks. Seven of the locks are between Montreal and Lake Ontario, and the rest make up the Welland Canal. The U.S. agency runs about 10 miles (16 kilometers) of canals, plus two locks near Massena, N.Y. The agencies jointly set tolls.

All the seaway's canals are at least 200 feet (61 meters) wide and 27 feet (8 meters) deep. The locks measure 80 feet (24 meters) wide, 766 feet (233 meters) long, and 30 feet (9 meters) deep. A ship passes through one of the locks in about 35 minutes.

The seaway is open from late March or early April to late December. In good weather, a ship can travel the entire route in about $1\frac{1}{2}$ days. But fog and high winds sometimes delay traffic. Also, ships are often delayed by the Welland Canal, which was not designed to handle the growing number of vessels that use the seaway.

The hydroelectric power project along the seaway is at the Moses-Saunders Dam, between Cornwall, Ont., and Massena, N.Y. The dam supplies about 1,600,000 kilowatts of electricity to sections of Ontario and New York. It is managed jointly by the Hydro-Electric Power Commission of Ontario and the New York Power Authority.

Lake St. Lawrence, which provides the water used by the power project, is more than 30 miles (48 kilometers) long. The lake is a calm stretch of water that once included an area of rapids. The three dams that form the lake eliminated the rapids. These dams are the Moses-Saunders, the Long Sault, and the Iroquois.

History

Early canals. Rapids on the St. Lawrence River hampered early European traders in Canada who wanted to use it as a shipping and exploration route. The Europeans solved this problem by digging canals around the areas of the rapids. One of the first canals was begun in 1680 by François Dollier de Casson, who was head of the Sulpician Order, a Roman Catholic religious group that then controlled Montreal. This canal was designed to enable fur traders to by-pass the Lachine Rapids near Montreal.

As more and more canals were built, the St. Lawrence River gradually became a major Canadian shipping route. The economies of Montreal and other Canadian cities along the river depended on this trade.

The Erie Canal opened in 1825 and began to attract much shipping away from the river. The canal, which was built by New York, extended across that state from the Hudson River to Lake Erie. It provided a shorter route between the Atlantic Ocean and the Great Lakes, and it served New York City, a major seaport. But the St. Lawrence remained a competitive route for goods being shipped to Britain. Canada was then a British colony and so Canadian merchants had certain tax advantages over Americans who exported goods to Britain. As a result, American merchants got higher prices by shipping goods to traders in Montreal than by selling them directly to the British market.

Canada also helped the St. Lawrence compete with the Erie by building the Welland Canal. This canal, completed in 1829, linked Lakes Erie and Ontario and provided a direct water route from the Atlantic Ocean to the Great Lakes region.

First construction plans. In 1895, Canada and the United States began to discuss a plan to improve the St. Lawrence for shipping. The project included deepening the river and the canals so that any ship could travel between the Atlantic and the Great Lakes.

In 1909, the Canadian and U.S. governments created the International Joint Commission to administer the boundary waters of the two countries. In 1921, the commission recommended that a joint navigation-power project be undertaken in the upper St. Lawrence area.

Many industries in Canada and the United States opposed the proposed project. Railroads and Atlantic ports, for example, feared that the seaway would compete for their freight business. Coal companies claimed that the power stations would reduce the amount of coal used to generate electricity in the region of the seaway.

Groups were organized in both countries to work for approval of the seaway project. These groups stressed

the international trade and the great amounts of inexpensive electricity that the project would bring to the Great Lakes region.

In 1932, Canada and the United States signed the St. Lawrence Deep Waterway Treaty. This agreement called for construction of a waterway 27 feet (8 meters) deep between Montreal and Lake Erie, plus four hydroelectric power stations. But the United States Senate rejected the treaty in 1934.

Agreements of 1941 and 1954. New interest in the proposed seaway occurred during World War II (1939-1945). The war created a great demand in both Canada and the United States for electricity and for ports in which to build ships. In March 1941, about nine months before the United States entered the war, the two nations signed the Great Lakes-St. Lawrence Basin Agreement. This agreement involved the same proposals as the 1932 treaty. The agreement also included plans for additional production of electricity at the Niagara Falls power project.

The agreement was subject to approval by the U.S. Congress. But it was set aside for more urgent legislation after the United States entered the war in December 1941, following the Japanese attack on Pearl Harbor.

In 1942, President Franklin D. Roosevelt considered issuing an executive order to start construction of the power project. Production of weapons and war materials had caused serious power shortages in Ontario and New York. Roosevelt decided against the order after learning that the project would take at least three years to complete.

The House of Representatives took up the agreement in 1943. But little was accomplished until 1951, when Canada announced plans to build the waterway on its own. Canada also offered to construct the hydroelectric project in cooperation with New York. At the same time, Canada created the St. Lawrence Seaway Authority to direct the undertaking.

Canada's actions caused U.S. supporters of the waterway to increase their efforts to obtain congressional approval of cooperation in the project. Finally, in 1954, Congress approved U.S. participation and created the St. Lawrence Seaway Development Corporation. Canada and the United States then made new plans for the seaway. These plans called for the present number of canals, locks, and power stations.

Construction of the seaway. The power project was begun in August 1954, and construction of the waterway itself started a month later. The Canadian and U.S. governments had to relocate railways and highways and about 6,500 people who lived in certain areas of Ontario and New York. These areas would be covered by the new reservoir, Lake St. Lawrence. The project flooded about 40,000 acres (16,000 hectares) of farmland in Canada and the United States. Six villages and two towns had to be abandoned. Canada and the United States built communities near Lake St. Lawrence for the displaced people. The power station began to produce electricity in 1958.

The seaway opened officially on June 26, 1959. However, ships had been using it since April. A Dutch ship, the *Prins Johan Willem Friso,* was the first oceangoing vessel to travel through the seaway to Chicago. It docked there on April 30.

During the first year of operation, the St. Lawrence Seaway carried about 20 million short tons (18 million metric tons) of cargo. However, several temporary problems hampered the waterway at first. Traffic jams were caused by slow-moving ships, whose pilots were unfamiliar with the seaway. Some ports on the Great Lakes could not handle the large number of vessels that used the waterway. Some ships that docked at these ports had to wait several days to be loaded or unloaded.

The seaway today. Although the seaway has been a success for commercial shipping, the Canadian government has lost money on its operation. The government has gradually increased tolls charged at its locks to reduce this loss. The United States has not lost as much money because it operates a smaller section.

Supporters of the seaway project expected it to be a major shipping route for general cargo as well as bulk cargo. However, the development of *container ships* resulted in the seaway's becoming chiefly a route for bulk cargo. General cargo is carried mainly by container ships, most of which are too large to enter the seaway. These ships carry cargo that can be stored in metal or wooden shipping units called *containers.* Containers are easy to handle, and they can be hauled inland by train or truck. Long, flat ships called *lake carriers* or *lakers* have been developed especially for Great Lakes traffic. Some lakers can navigate ocean waters. Carman Miller

Related articles in *World Book* include:
Great Lakes
Inland waterway
Saint Lawrence River
Saint Lawrence Seaway Development Corporation
Welland Ship Canal

Saint Lawrence Seaway Development Corporation is an agency of the United States Department of Transportation. It operates the St. Lawrence Seaway in cooperation with the St. Lawrence Seaway Authority of Canada. The corporation maintains navigation on the part of the seaway system that lies between Lake Erie and Montreal, within the territorial limits of the United States. It also operates the Eisenhower and Snell locks near Massena, N.Y. The corporation also develops trade and traffic for the entire seaway, including the Great Lakes.

The U.S. government created the agency in 1954 to build, operate, and develop the United States portion of the seaway. An administrator appointed by the President heads the corporation. Critically reviewed by the St. Lawrence Seaway Development Corporation

Saint Lazarus, Order of, was a Christian religious organization of knights and nurses founded in Jerusalem about 1120. Its official name was the Military and Hospitaller Order of St. Lazarus of Jerusalem. The order was established to operate hospitals, especially for lepers; to assist pilgrims; and to spread the Christian faith. In 1253, the order transferred its activities to Europe. It continues today as an honorary organization based in Paris. David G. Schultenover

Saint Leger, *LEHJ ur,* **Barry** (1737-1789), a British soldier, fought against the Americans in the Revolutionary War (1775-1783). St. Leger's retreat to Canada after the Battle of Oriskany in 1777 was instrumental in upsetting the British campaign plan, and contributed to Burgoyne's surrender at Saratoga (see **Burgoyne, John**). St. Leger also fought in the French and Indian War (1754-1763). Paul David Nelson

© Corbis

St. Louis lies in eastern Missouri, on the Mississippi River. The Gateway Arch, designed by the Finnish-born American architect Eero Saarinen, rises 630 feet (192 meters) on the city's riverfront.

Saint Louis, *saynt LOO ihs,* is the second largest city in Missouri and a leading industrial and transportation center of the United States. Among Missouri's cities, only Kansas City has more people. But St. Louis has the state's largest metropolitan area.

St. Louis lies on the west bank of the Mississippi River, about 10 miles (16 kilometers) south of where the Mississippi meets the Missouri River. This location has made St. Louis the busiest inland port on the Mississippi River.

In 1764, French fur traders built a post on the site of what is now St. Louis. They chose the site because Indians bringing furs to trade could reach it easily by canoe. The French named the settlement for King Louis IX, who had been made a saint. It came under the control of the United States when President Thomas Jefferson bought the Louisiana Territory from France in 1803 (see **Louisiana Purchase**).

During the first half of the 1800's, St. Louis served as a gateway to the West and as a main port for Mississippi River steamboats. The city became a railroad center after the Civil War (1861-1865). During the late 1800's, industrial expansion helped St. Louis become one of the nation's chief urban centers.

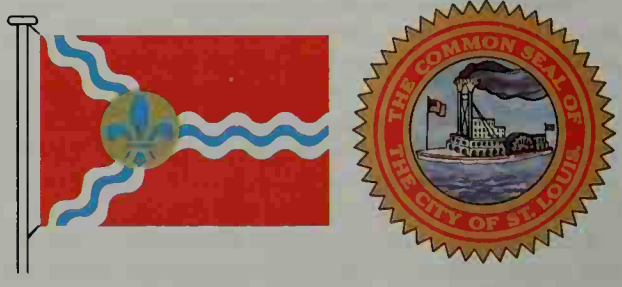
Metropolitan St. Louis

St. Louis covers 61 square miles (158 square kilometers). The city's metropolitan area extends across the Mississippi River into Illinois.

In Missouri, the metropolitan area includes Franklin, Jefferson, Lincoln, St. Charles, St. Louis, and Warren counties, and the city of St. Louis. In Illinois, the metropolitan area covers Clinton, Jersey, Madison, Monroe, and St. Clair counties.

The city extends along the Mississippi River for 19 miles (31 kilometers). The Jefferson National Expansion Memorial stands on the riverfront. This memorial honors Thomas Jefferson, the Louisiana Purchase, and the pioneers who settled the West. It includes the Gateway Arch, 630 feet (192 meters) high, the nation's tallest monument. Small cars inside the monument carry visitors to the top for a magnificent view of the city. More than 2 $\frac{1}{2}$ million people visit the monument annually.

The historic riverfront area includes the Old Courthouse, site of the famous Dred Scott slavery trial. Also in



Symbols of St. Louis. The two wavy bars on the flag represent the Mississippi and Missouri rivers, and the fleur-de-lis in the disk stands for the French background of St. Louis. The steamboat on the city seal symbolizes the city's early growth.

Facts in brief

Population: *City*—348,189. *Metropolitan area*—2,603,607.
Area: *City*—61 mi² (158 km²). *Metropolitan area*—6,393 mi² (16,558 km²), excluding inland water; 2,621 mi² (9,770 km²) in Missouri, 3,772 mi² (6,788 km²) in Illinois.
Altitude: 455 ft (139 m) above sea level.
Climate: *Average temperature*—January, 33 °F (1 °C); July, 81 °F (27 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—35 in (89 cm). For the monthly weather in St. Louis, see **Missouri** (Climate).
Government: Mayor-council. *Terms*—4 years.
Founded: 1764. Incorporated as a town, 1809; as a city, 1822.

the area is the Old Cathedral, a Roman Catholic church that was completed in 1834.

Downtown St. Louis lies between the riverfront and 15th Street. Many of the city's civic buildings rise around downtown's Memorial Plaza. These civic buildings include City Hall, the Municipal Courts Building, and the Soldiers' Memorial.

The residential areas of St. Louis spread outward from the downtown area. About two-thirds of the dwellings are single-family homes. Like many other industrial cities, St. Louis has neighborhoods with run-down buildings.

The metropolitan area. St. Louis suburbs in Missouri include Chesterfield, Florissant, Kirkwood, St. Charles, University City, and Webster Groves. Several bridges across the Mississippi link St. Louis with the Illinois part of its metropolitan area. The historic Eads Bridge extends from the foot of Washington Avenue to East St. Louis. This steel-arch bridge was considered an engineering wonder when it was completed in 1874.

People

The city includes many people of African, English, French, German, Irish, Italian, Polish, and Scottish descent. A little more than half of the people of St. Louis are African Americans.

Economy

Industry. The production of transportation equipment is the city's leading manufacturing activity, and St. Louis is an important automobile-manufacturing center. St. Louis plants also produce military airplanes.

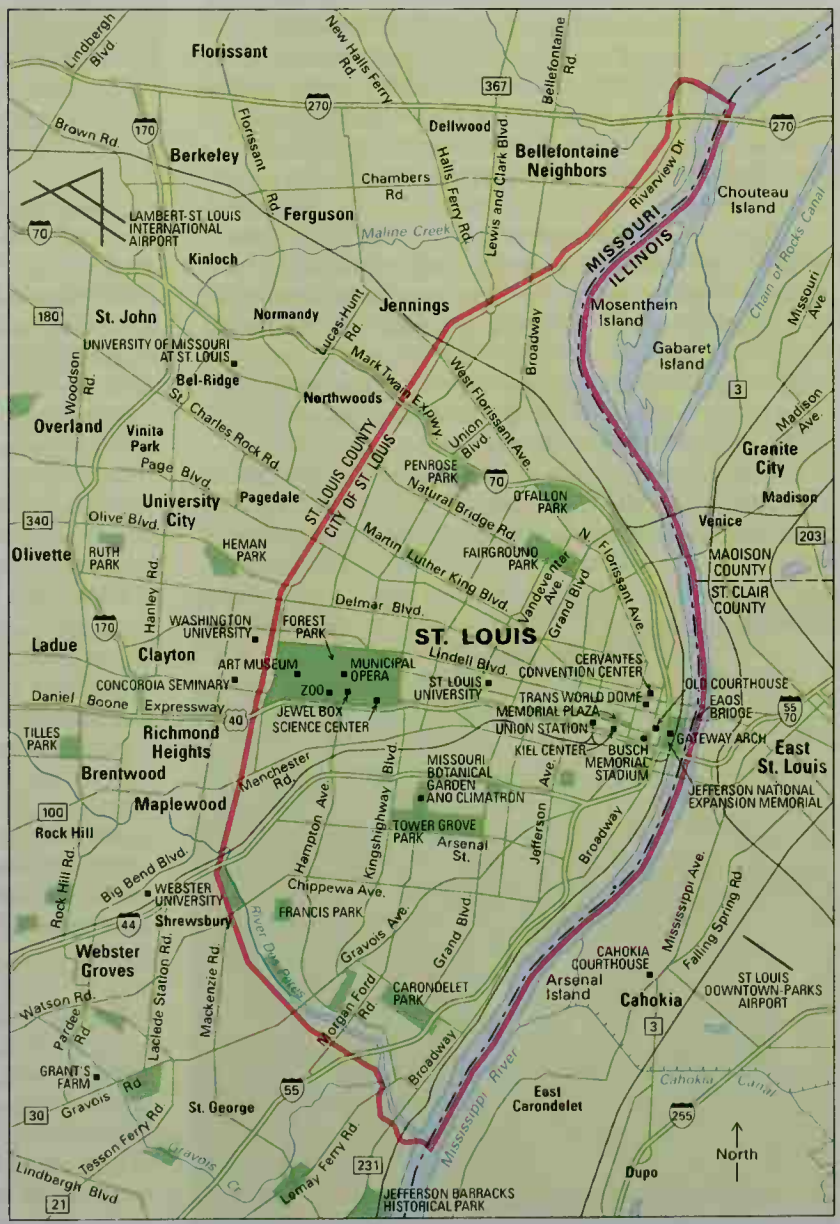
The metropolitan area of St. Louis is the home of Anheuser-Busch, Inc., the largest U.S. beer brewer. The area is also an important manufacturer of chemicals, food and food products, and such primary metals as

St. Louis

St. Louis lies in eastern Missouri below the junction of the Mississippi and Missouri rivers. The map at the right shows the city and its major points of interest. The map below shows the Greater St. Louis area, which includes some Illinois communities.

City boundary
County boundary
State boundary
Park
Expressway
Other road
Railroad
Point of interest

Greater St. Louis area



WORLD BOOK maps

iron and lead. St. Louis and Washington universities have major centers of medical research. The city has also become a center of research and development in the plant and life sciences fields, particularly in the area of genetic engineering for agricultural applications. Many corporations have their headquarters in the metropolitan area. They include Emerson and May department stores.

Transportation, communication, and finance. St. Louis is a leading U.S. rail and trucking center. Eleven rail freight lines, the Amtrak rail passenger service, and more than 550 trucking companies serve St. Louis. Several interstate highways connect in the city. Lambert-St. Louis International Airport is one of the nation's busiest airports.

Public transportation is not heavily used in St. Louis. The Bi-State Development Agency, created by the legislatures of Missouri and Illinois, operates a bus system that serves the city and suburbs. However, the bus system has difficulty providing adequate service and meeting costs. Unlike the bus system, Bi-State's MetroLink light rail passenger system has been popular since it began operating in 1993. MetroLink crosses the Mississippi River, operating between Lambert Airport on the west and a point near Belleville, Illinois, on the east. Plans call for expanding the system to the western suburbs of St. Louis.

St. Louis lies in the heart of the U.S. inland waterway system and is one of the nation's largest inland ports. The city handles about 32 million tons (29 million metric tons) of cargo yearly. All of the major barge lines serve the city.

St. Louis is the financial center of the Central Mississippi River Valley. It serves as the headquarters of the Eighth Federal Reserve District Bank.

St. Louis has one general daily newspaper, the *St. Louis Post-Dispatch.* The paper dates from 1878, when American newspaperman Joseph Pulitzer bought the *St. Louis Dispatch* and the *Evening Post* and combined them into one paper.

Monsanto Corporation

St. Louis researchers examine soybean plants at a center for research in genetic engineering for agricultural applications.

Education

The St. Louis public school system includes about 100 schools, with a total of about 44,000 students. African Americans make up approximately 80 percent of the public school enrollment. Through a voluntary program designed to promote racial integration, many black students are bused to schools in white suburban areas. Many white students, in turn, are bused to schools in black areas. About 58,000 students attend more than 200 Roman Catholic elementary and secondary schools.

St. Louis University, founded in 1818, is the oldest university west of the Mississippi River. Other schools in or near St. Louis include Barnes College, Concordia Seminary, Fontbonne College, Harris-Stowe State College, Maryville University of St. Louis, Missouri Baptist College, St. Louis College of Pharmacy, Southern Illinois University at Edwardsville, Washington University in St. Louis, Webster University, and a branch of the University of Missouri.

The main St. Louis Public Library owns more than a million books. It has 16 branches.

Cultural life

The arts. The St. Louis Symphony Orchestra, the second oldest orchestra in the United States, performs in Powell Hall. The orchestra began as a choral group in 1880, about 40 years after the New York Philharmonic Orchestra was established. Every summer, the St. Louis Municipal Opera presents musical comedy, light opera, and concerts in an open-air theater in Forest Park.

Other musical groups performing in the area include the Opera Theatre of St. Louis and the St. Louis Philharmonic. The St. Louis Art Museum is notable for its collection of pre-Columbian art. The American Theatre, the Fox Theatre, and the Repertory Theatre of St. Louis present major stage attractions.

Museums. The Museum of Westward Expansion, beneath the Gateway Arch, features exhibits on the history of the West. The Jefferson Memorial Building displays trophies of Charles A. Lindbergh, who in 1927 made the first solo flight across the Atlantic Ocean. In the same building, a museum operated by the Missouri Historical Society has exhibits on the fur trade and the Lewis and Clark expedition to the Northwest. The National Museum of Transport, in Kirkwood, has old locomotives, streetcars, buses, airplanes, and horse-drawn equipment. The Magic House, also in Kirkwood, has science exhibits for children.

Recreation

Parks. St. Louis has about 70 parks. Forest Park, covering 1,374 acres (556 hectares), is one of the largest city parks in the United States. It includes golf courses, lagoons for boating, and picnic areas. The park is the site of the St. Louis Zoo, noted for its animal shows; the Jewel Box, a building that features flower exhibits; the St. Louis Art Museum; and the St. Louis Science Center, which includes a planetarium and a museum of science and natural history. The Missouri Botanical Garden, near Tower Grove Park, has one of the nation's finest collections of plant life. The garden includes a Japanese gar-

Detail of a lithograph (1840's) by T. Moore; Missouri Historical Society, St. Louis

The St. Louis riverfront served as a main port for steamboats that traveled on the Mississippi River during the mid-1800's.

den and the Climatron, a modern greenhouse that grows a variety of tropical plants.

Sports. St. Louis has three major professional athletic teams. One of them is a major league baseball team, the St. Louis Cardinals of the National League. The others are the St. Louis Rams of the National Football League and the St. Louis Blues of the National Hockey League.

Places to visit. The Gateway Arch, described in *The city* section of this article, is a major attraction for visitors. Other interesting places to visit include:

Aloe Plaza, on Market Street. The plaza features the *Meeting of the Waters* fountain designed by the sculptor Carl Milles. The fountain portrays the meeting of the Mississippi and Missouri rivers.

Grant's Farm, in Grantwood. This 281-acre (114-hectare) area includes a cabin owned by Ulysses S. Grant before the Civil War. Buffalo, deer, and elk roam through a nearby park.

Union Station, on Market Street. This former train station is now a shopping, dining, and entertainment complex.

Government

St. Louis has a mayor-council form of government. The voters elect the mayor, the 28 members of the Board of Aldermen, and the president of the Board of Aldermen—all to four-year terms. The city's chief sources of revenue are taxes on property and retail sales and taxes on individual and business earnings. The earnings tax is collected from everyone who lives or works in St. Louis.

Unlike most cities, St. Louis does not control its own police department or its department of elections. Both departments are run by commissions that consist chiefly of members appointed by Missouri's governor.

St. Louis is also one of the few U.S. cities that is not in a county. In 1876, St. Louis withdrew from St. Louis County and became an independent city. It took this action so it could elect officials who would take a special interest in St. Louis affairs. The city has the status of a county—though it is not officially one—so it can be represented in the Missouri legislature. The city faces Illinois on the east, but St. Louis County borders the city on the other three sides. St. Louis has often tried to extend its borders, but the county has opposed such changes. The county has blocked the city's efforts to rejoin the county and many of its proposals to form joint agencies to handle metropolitan problems.

History

Early settlement. The Missouri and Osage Indians lived in the St. Louis region when French explorers arrived in the mid-1600's. In 1763, a French fur trader, Pierre Laclède Liguest, and his 14-year-old stepson, René Auguste Chouteau, visited the site of what is now St. Louis. The next year, they established a settlement there and opened a trading post.

The community was actually founded on Spanish territory. In a secret treaty signed in 1762, France had given all its territory west of the Mississippi River to Spain. The French gave their land east of the river to Britain in 1763. St. Louis grew rapidly as French settlers, who preferred Spanish to British rule, crossed the river and settled around the trading post.

The 1800's. France regained control of the St. Louis region in 1800, under another treaty. On March 10, 1804, the transfer of the northern part of the Louisiana Purchase region from France to the United States took place in St. Louis. The settlement became a key point in the westward expansion of the United States. The expeditions of Meriwether Lewis and William Clark and of Zebulon M. Pike started from the area. Keelboats, and later steamboats, traveled up the Missouri River and its tributaries and returned with fortunes in furs.

St. Louis was incorporated as a town in 1809. In 1822, when it became a city, St. Louis had a population of about 5,000. During the mid-1800's, many German and Irish workers settled in the city. Between 1840 and 1860, the population increased from 16,469 to 160,773. During the Civil War (1861-1865), St. Louis served as the western headquarters of the Union Army. Railroad construction brought steady growth after the war. By 1870, St. Louis had 310,864 people and was the third largest U.S. city behind New York City and Philadelphia.

In 1874, the Eads Bridge was completed across the Mississippi River. The Illinois coal fields then became easier to reach from St. Louis, and the city's suburbs in that state began to grow. The city became an important manufacturing center during the late 1800's.

The 1900's. The Louisiana Purchase Exposition was held in Forest Park in 1904, along with the Olympic Games. The exposition, also called the St. Louis World's Fair, boosted trade and culture in the city.

St. Louis continued to grow during the early 1900's. By 1920, its population reached 772,897. In 1927, a group of St. Louis business people financed Charles A. Lindbergh's historic flight from the United States to France. Lindbergh's airplane was named *Spirit of St. Louis.*

During World War II (1939-1945), St. Louis factories produced military equipment for the Allies. By 1950, 856,796 people lived in the city.

A nationwide trend toward suburban living began during the 1950's in the United States. This trend resulted in thousands of whites moving to newly built areas

outside the city. The population of St. Louis fell to 750,026 by 1960. In addition, problems of citywide decay became increasingly serious during the 1950's. St. Louis built new schools, expressways, and housing for low-income people during the 1950's and 1960's to improve living conditions in the city.

Between 1970 and 1980, the population of St. Louis declined more than that of any other major U.S. city. During this period, the population fell from 622,236 to 452,801, a decrease of more than 27 percent. Between 1980 and 1990, the population fell to 396,685, a decrease of 12 percent.

The opening of the $36-million Cervantes Convention Center (now called America's Center) in downtown St. Louis in 1977 spurred the development of that area. During the late 1970's and early 1980's, developers converted nine blocks of downtown St. Louis into an entertainment district. The district, called Laclede's Landing, features restaurants, nightclubs, offices, and apartments in restored old buildings. In 1985, two downtown malls were completed: St. Louis Centre, an indoor shopping mall; and Union Station, a train station remodeled into a shopping, dining, and entertainment complex.

In 1993, St. Louis voters elected Freeman R. Bosley, Jr., mayor. Bosley, a Democrat, was the city's first African American mayor. He served until 1997.

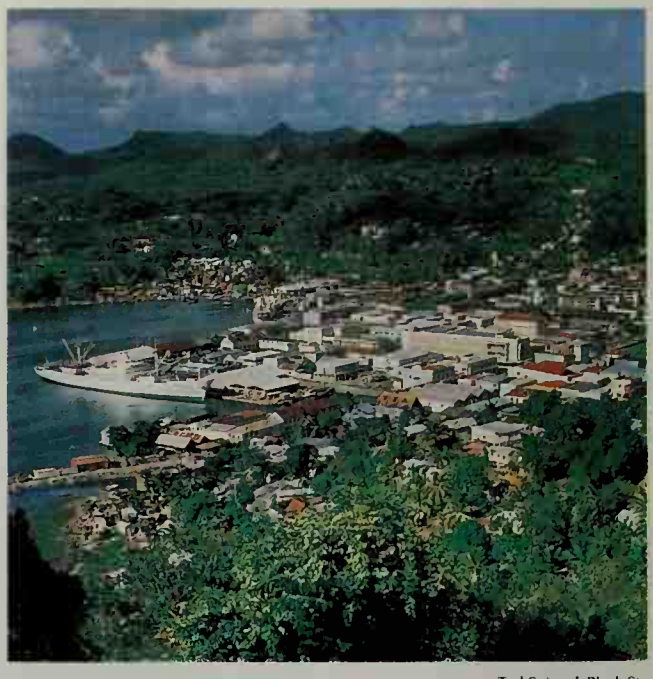
Recent developments. According to the 2000 census, the city had 348,189 people. The population had decreased by 12 percent during the 1990's. St. Louis officials have encouraged city redevelopment projects to try to help reverse the population trend. The federal government has helped fund programs to restore housing in the city's run-down neighborhoods.

Laszlo K. Domjan

See also Missouri (pictures).

Saint Lucia, *LOO shuh* or *loo SEE uh,* is an island country in the West Indies. It is one of the Windward Islands, a group of islands in the southeastern West Indies. St. Lucia lies in the Caribbean Sea about 240 miles (385 kilometers) north of Venezuela. It has an area of 240 square miles (622 square kilometers) and a population of about 158,000.

St. Lucia became independent in 1979 after being ruled by Britain since 1814. Castries, on the northwest coast, is the capital and largest city (see Castries). The



Ted Spiegel, Black Star

St. Lucia is a small island country in the Caribbean Sea. St. Lucia has a tropical climate. The mountainous terrain of the island is covered with lush vegetation.

East Caribbean dollar is the basic unit of currency. For a picture of the St. Lucian flag, see **Flag** (Flags of the Americas).

Government. St. Lucia is a constitutional monarchy and a member of the Commonwealth of Nations (see **Commonwealth of Nations**). A prime minister heads the country's government. The prime minister governs with the aid of a Cabinet of 10 members. A 17-member House of Assembly and an 11-member Senate pass the nation's laws. The members of the House are elected by the people. Government leaders appoint Senate members.

People. About 90 percent of the people of St. Lucia are descendants of black African slaves. Early British and French settlers brought the slaves to the island. Whites make up most of the rest of the population. They include descendants of the British and French settlers. More than 90 percent of the islanders are Roman Catholics.

About 52 percent of the islanders live in rural areas, and about 48 percent live in urban areas, which lie near the coast. English is the nation's official language. But islanders commonly speak a French dialect. Children must attend school from the ages of 5 to 15. St. Lucia has a technical school and a teachers college.

Land and climate. St. Lucia is mountainous and has little flatland. Tropical vegetation covers the country. Mount Gimie, St. Lucia's highest peak, rises 3,117 feet (950 meters) near the center of the island. Gros Piton and Petit Piton, twin peaks in the southwest area, are ancient volcanic cones. St. Lucia averages about 100 inches (254 centimeters) of rain annually. Temperatures range from about 85 to 68 °F (29 to 20 °C). Mountain temperatures may fall lower.

Economy of St. Lucia is based on agriculture. The islanders use most of the produce that they grow. However, bananas, cocoa, and coconuts are exported. Tourism is an important source of income. Factories manufacture clothing, electrical parts, paper products,

St. Lucia

WORLD BOOK maps

and textiles. However, industry plays a minor role in the economy.

A paved road encircles the island and connects the main towns with Castries. St. Lucia has two airports.

History. The Arawak Indians were the original inhabitants of St. Lucia. They were conquered by the Carib Indians in the 1300's. During the early 1600's, the Carib fought the French and British and prevented them from settling on the island. After the Carib and the French signed a peace treaty in 1660, French settlers established a permanent colony on St. Lucia. The French, and also the British, later began other settlements there.

Control of St. Lucia alternated between Britain and France 14 times until Britain took over in 1814. Through the years, both the British and French brought slaves from Africa to work on plantations. In 1833, Britain banned slavery throughout its empire. The British gradually gave St. Lucia more control over its affairs, and the country became independent on Feb. 22, 1979.

In 1983, St. Lucia and several other Caribbean nations joined the United States in an invasion of Grenada to overthrow a Marxist government there. See Grenada (History and government) for details. Gerald R. Showalter

See also Walcott, Derek.

Saint Mark, Basilica of, is the Roman Catholic cathedral of Venice, Italy. It is also called the Cathedral of St. Mark. The basilica is named for Saint Mark, the patron saint of Venice.

The basilica is built primarily in the Byzantine style, though its architecture also reflects Romanesque and Gothic influences. The building is constructed in the shape of a Greek cross, which has four arms of equal length. The church is 251 feet (76½ meters) long, and it is 205 feet (62½ meters) wide at its widest point. A dome rises over each arm and over the place where the arms meet. A separate *campanile* (bell tower) stands near the basilica in St. Mark's Square.

The present church is the third on the site. It was built as the palace chapel for the *doge* (ruler) of Venice, and was consecrated in 1073. It was designated a cathedral in 1807. Its interior is richly decorated with mosaics, carvings, and colored marble. Many of these works of art were brought from the Byzantine capital of Constantinople (now Istanbul) by European warriors fighting the Fourth Crusade about 1204. The crusaders also brought four bronze horses that stand over the basilica's entrance and many precious objects now in its treasury. William J. Hennessey

See also Campanile; Venice (picture); World, History of the (picture: The Basilica of St. Mark).

Saint Marys River carries the waters of Lake Superior into Lake Huron. The river is about 40 miles (64 kilometers) long and forms part of the boundary between Ontario and Upper Michigan. Islands divide the river into two main channels, and each channel spreads out into several lakelike bays. The St. Marys Rapids, which are near the northern end of the river, fall nearly 20 feet (6 meters) within 1 mile (1.6 kilometers). The Soo canals and locks have been built so ships can bypass the rapids.

The rapids furnish power for industry. A railroad bridge crosses the rapids. The 2-mile (3.2-kilometer) International Bridge carries traffic across the St. Marys River at Sault Ste. Marie. George B. Priddle

Saint Moritz (pop. 5,426), is a famous resort town in the Alps of eastern Switzerland. It lies 6,037 feet (1,840 meters) above sea level in the Engadin Valley of the *canton* (state) of Graubünden (see Switzerland [map]). It stands between mountain slopes and along a small lake.

The economy of St. Moritz is based on tourism. Visitors enjoy the area's scenic beauty, clean air and sunshine, big hotels and restaurants, and varied recreational facilities. Favorite activities there include skiing, ice skating, sailing, swimming, and hiking.

Roman soldiers built a settlement on the site of St. Moritz in the 50's B.C. The town became a major tourist resort in the 1800's. It was the site of the Winter Olympics in 1928 and 1948. The natives of St. Moritz speak Romansh, a language used by only about 50,000 people in the valleys of Graubünden. Heinz K. Meier

Saint Nicholas, *NIHK uh luhs* or *NIHK luhs,* **Feast of,** is a children's festival celebrated on December 6, the feast day of Saint Nicholas. The saint was a bishop who lived in Asia Minor during the A.D. 300's. He has been the patron saint of children since the Middle Ages. The festival is observed primarily in Europe. In some countries, children fill their shoes with straw and carrots for Saint Nicholas' horse on the night of December 5, St. Nicholas Eve, when Saint Nicholas visits their homes. In the morning, they find the straw and carrots replaced by small toys and cookies. But if children have been naughty, they receive a whipping rod to remind them that someone is watching their behavior.

The Dutch brought the festival to America during the 1600's. In the 1800's, the figure of Saint Nicholas was changed into Santa Claus. However, St. Nicholas Day continued to be observed in the United States in many communities well into the 1900's. Robert J. Myers

See also Christmas (Gift giving); Nicholas, Saint; Santa Claus; Steen, Jan (picture).

Saint Patrick's Cathedral is the seat of the Roman Catholic Archdiocese of New York. The structure is located at 50th Street and Fifth Avenue, facing Rockefeller Center in New York City. The cathedral was designed by American architect James Renwick and constructed between 1858 and 1879. It is one of the best-known examples of Gothic Revival architecture in the United States. The cathedral's west front and pair of matching towers are based on French Gothic architecture. See New York City (A visitor's guide). J. William Rudd

Saint Patrick's cross. See Flag (pictures: Historical flags of the world [Crosses in the British flag]).

Saint Patrick's Day is celebrated on March 17th, the feast day of Saint Patrick, the patron saint of Ireland. Saint Patrick was a missionary to Ireland in the A.D. 400's who converted the Irish to Christianity. St. Patrick's Day is a national holiday in Ireland. It also is celebrated outside of Ireland in cities with a large number of people of Irish descent.

In Ireland, St. Patrick's Day is primarily a religious holiday. People honor Saint Patrick by attending special religious services, enjoying family and community gatherings, and wearing shamrocks. According to legend, Saint Patrick used a shamrock to explain the idea of the Trinity to the Irish (see Shamrock).

In the United States, St. Patrick's Day is primarily a *secular* (nonreligious) holiday. Many people wear green clothing, and they hold parties and march in parades.

The first St. Patrick's Day celebration in the United States was held in Boston in 1737. Today, more than 100 cities hold parades. The St. Patrick's Day parade in New York City is the largest. Robert J. Myers

See also **Patrick, Saint.**

Saint Paul (pop. 287,151) is the capital and second largest city of Minnesota. Only Minneapolis, St. Paul's "twin city," has more people. The metropolitan area that includes the two cities has a population of 2,968,806. St. Paul lies in southeastern Minnesota. For location, see **Minnesota** (political map); **Minneapolis** (map). The city serves as the distribution and transportation center for a rich Midwestern farm area.

In 1840, several families and a French-Canadian trader named Pierre Parrant founded a settlement that grew into St. Paul. The settlement was first known by Parrant's nickname, Pig's Eye. It became St. Paul after the construction in 1841 of a church dedicated to that saint.

The city. St. Paul covers 56 square miles (145 square kilometers), including 3 square miles (8 square kilometers) of inland water. It is the seat of Ramsey County. The city lies on both banks of the Mississippi River, but most of it is on three terraces on the north bank. The lowest terrace consists of factories and railroad yards. The business district stands on the middle terrace, and homes occupy the highest one.

The State Capitol is at the north end of Wabasha Street in downtown St. Paul. The City Hall and County Courthouse share a building that stands south on Wabasha, on the north bank of the river. The Cathedral of St. Paul, a city landmark, is on Summit Avenue.

Many downtown buildings are linked by enclosed pedestrian bridges over the streets. This *skyway* system, the nation's longest, spans about 5 miles (8 kilometers).

About 95 percent of St. Paul's people were born in the United States. The city's population includes groups of German, Irish, Polish, and Scandinavian descent. American Indians, Asians, blacks, and Hispanic Americans make up about 33 percent of the population of St. Paul.

Economy. St. Paul ranks as an important distribution and transportation center. Retail and wholesale warehouses operate in the city and its suburbs. More than 150 trucking lines serve the Twin Cities area.

Four railroads provide St. Paul with freight service. Passenger trains use a terminal in St. Paul. Many airlines serve St. Paul Downtown Airport, south of the Mississippi River, and the Minneapolis-St. Paul International Airport, southwest of the city. Barges on the Mississippi carry goods to and from St. Paul.

St. Paul's two largest employers are Northwest Airlines, which has its headquarters there, and the state government. The city has about 500 factories. Nonelectric machinery is the chief product. Other manufactured products include automobiles, cosmetics, electrical machinery, fabricated metals, plastics, transportation equipment, and wood products.

Education and cultural life. St. Paul's public school system includes 50 elementary and junior high schools and 9 high schools. The city also has about 50 parochial and private schools.

The city's institutions of higher learning include the College of Associated Arts; the College of St. Catherine; Concordia College; Hamline University; Macalester College; Metropolitan State University, which is a part of the Minnesota State University System; several colleges and departments of the University of Minnesota Twin Cities Campus; and the University of St. Thomas.

The *St. Paul Pioneer Press* is the city's main daily newspaper and the oldest in the state. The newspaper was founded in 1849 as the *Minnesota Pioneer*. The St. Paul Public Library serves the city.

St. Paul's places of interest include Summit Avenue, with its many old mansions that were once owned by wealthy business executives. Other popular attractions are the Ordway Center for the Performing Arts, the Minnesota Historical Society Museum, and the Science Museum of Minnesota. The St. Paul Council of Arts and Sciences administers the Science Museum as well as the Minnesota Museum of Art, the Philharmonic Society, and the North Star Opera Association.

The city's park system includes more than 50 major recreation sites. The St. Paul area has more than 30 lakes. Major annual attractions in St. Paul include the Winter Carnival in January and February and the Minnesota State Fair, held from late August through Labor Day.

St. Paul is the home of the Minnesota Wild of the National Hockey League. Three other professional sports teams play at facilities in neighboring Minneapolis. The Minneapolis teams are the Minnesota Twins baseball team of the American League, the Minnesota Vikings of the National Football League, and the Minnesota Timberwolves of the National Basketball Association.

Government. St. Paul has a mayor-council form of government. Voters elect a mayor to a four-year term, and they elect seven city council members to two-year terms. Property taxes provide most of St. Paul's revenue.

History. Sioux Indians lived in what is now the St. Paul area long before white people arrived. In 1819, the U.S. Army set up Fort St. Anthony in a temporary building there. Between 1820 and 1822, American soldiers under Colonel Josiah Snelling built Fort St. Anthony as a permanent fort. The fort covered a large area on the west side of the Mississippi River and soon attracted settlers. It was renamed Fort Snelling in 1825.

In 1840, several families and a French-Canadian trader, Pierre Parrant, left the military property. They moved farther east and founded the settlement that became St. Paul. In 1841, Lucian Galtier, a Roman Catholic priest, built St. Paul's Chapel there. Steamboats began to stop at the settlement. St. Paul soon became an important fur-trading post and a busy river port.

In 1849, St. Paul was incorporated as a town and became capital of the Minnesota Territory. About 840 people lived in the town at that time. The settlement that became Minneapolis was established in 1849. During the mid-1800's, St. Paul was the leading commercial center of the Northwest.

St. Paul received its city charter in 1854. It had a population of 10,401 by 1860. During this period, the rich farmlands around St. Paul and jobs in the nearby forests and iron ore mines attracted thousands of European immigrants. The railroad financier James J. Hill helped the civic, cultural, and industrial development of St. Paul in the late 1800's. For example, he donated funds to build a library and the Cathedral of St. Paul. By 1893, Hill had extended the Great Northern Railway from St. Paul to Puget Sound in the state of Washington (see **Hill, James Jerome**). Also at this time, Archbishop John Ireland be-

came a civic and religious leader in St. Paul. He helped establish immigrants and other settlers in the area.

St. Paul prospered through trade and transportation. Large flour mills helped Minneapolis grow. During the late 1800's and early 1900's, Minneapolis grew faster than St. Paul because of greater industrial development.

St. Paul's economy slumped during the 1920's and the Great Depression of the 1930's. By 1940, downtown St. Paul had become old and shabby. In the 1950's, city leaders began to plan urban renewal projects.

In the 1970's and 1980's, St. Paul completed many downtown construction and rehabilitation projects. The new constructions included the Capitol Centre, which covers 12 blocks and features apartment and office buildings and stores; the St. Paul Civic Center; the 1,800-seat Ordway Music Theatre (now the Ordway Center for the Performing Arts); and the 37-story World Trade Center. One major rehabilitation project was Landmark Center, a performing arts and cultural center.

A new Smith Avenue High Bridge was completed across the Mississippi River in St. Paul in 1987. It replaced the original Smith Avenue High Bridge, which was demolished in 1985.

In the late 1990's, St. Paul again began extensive renovation of its downtown and riverfront areas. The projects included the construction of the Science Museum of Minnesota, which opened in 1999, and a new sports and entertainment arena, which was completed in 2000. In 2001, the city approved plans to redevelop the riverfront's Upper Landing area. The project, scheduled for completion in 2003, will feature housing, commercial space, parks, a trail, and a public plaza. Ruben A. Rosario

See also Minnesota (Climate; pictures).

Saint Paul's Cathedral. See London (Churches: picture).

Saint Peter's Basilica, also called St. Peter's Church, in Vatican City, is the world's largest Christian church. It is the second church to stand above the *crypt* (tomb) believed to hold the body of Saint Peter, the first pope.

St. Peter's is built in the shape of a cross. The church is almost 700 feet (210 meters) long and about 450 feet (137 meters) across at its widest point. It covers more than 18,000 square yards (15,100 square meters). The *nave* (center aisle) is about 150 feet (46 meters) high. The building's most outstanding architectural feature is its magnificent dome, designed by Michelangelo. The dome rises more than 400 feet (120 meters) from the floor and measures 138 feet (42 meters) in diameter.

The exterior. The church was given an impressive setting by Gian Lorenzo Bernini, one of its architects. An avenue almost 1 mile (1.6 kilometers) long leads from the Tiber River to the *Piazza di San Pietro* (Square of St. Peter), a large open space in front of the church. The piazza, which was completed in 1667, contains two fountains and two *colonnades* (rows of columns) arranged in semicircles on opposite sides of the piazza.

A red granite *obelisk* (shaft) stands 85 feet (26 meters) high in the piazza's center. It was brought to Rome from Egypt about A.D. 37, and was moved to the piazza in 1586.

The interior of the church is decorated in baroque style. Bernini, who was also a sculptor, created many of its famous features in the 1650's. He built the elaborate bronze *baldacchino* (canopy) over the main altar, which stands beneath the dome. Bernini also designed papal tombs and monuments for the church. Marble, gilding, and mosaics decorate the walls and ceiling. Chapels, altars, and tombs line the walls. Michelangelo's famous sculpture, the *Pietà,* stands in one of the chapels.

History. The first St. Peter's was begun by Constantine the Great about 325. He built the church to celebrate his acceptance of Christianity.

The church was modeled on the *basilica,* a rectangular building used as a meeting hall by the Romans (see Basilica). Four rows of columns, extending almost the length of the church, divided it into a nave with two aisles on either side. Throughout the Middle Ages, many people made pilgrimages to the church. In 1452, Pope Nicholas V began to restore and expand St. Peter's. The restoration continued until 1506, when Pope Julius II decided to rebuild the church completely. He demolished the original church, and only the tomb and a few

S. Kanno, FPG

St. Peter's Basilica in Vatican City stands over the tomb believed to contain Saint Peter's body. The basilica, built in the shape of a cross, can hold more than 50,000 people. A large *piazza* (square) lies in front of the basilica.

details of the earlier structure remain.

During its construction, 10 different architects worked on St. Peter's and changed its design. The first architect was Donato Bramante. He designed a domed, perfectly symmetrical church in the form of a *Greek cross* (a cross with four arms of equal length). Other famous architects of St. Peter's included Michelangelo, Giacomo della Porta, and Carlo Maderno. Michelangelo changed Bramante's plan for a balanced and restful dome into a dynamic construction. He put a *drum* (ring) at the base of the dome that appears to be squeezing the dome and forcing its sides to spring upward. Giacomo della Porta continued Michelangelo's dynamic plan and completed the dome in 1590. During the early 1600's, Carlo Maderno lengthened the nave, so that the church took the form of a *Latin cross* (a cross with a short horizontal bar crossing a longer vertical bar above the center). Maderno also designed the church's massive *facade* (front). The building was dedicated in 1626 by Pope Urban VIII, but other parts were added to the structure later.

William J. Hennessey

Related articles in *World Book* include:
Architecture (Later Renaissance architecture)
Bernini, Gian Lorenzo
Bramante, Donato
Michelangelo
Rome (picture: An air view of Rome; Churches, palaces, and fountains)
Vatican City (with picture)

Saint Petersburg (pop. 4,695,400), formerly *Leningrad,* is Russia's second largest city. Only Moscow, the capital, has more people. St. Petersburg is a major Russian port and one of the world's leading industrial and cultural centers. The city lies in northwestern Russia, at the eastern end of the Gulf of Finland, an arm of the Baltic Sea. For the location of St. Petersburg, see **Russia** (political map).

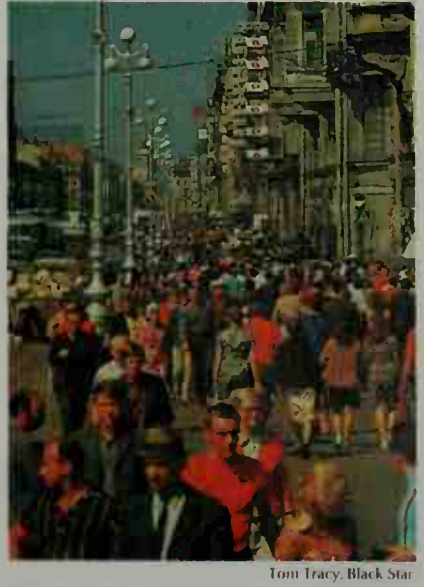
St. Petersburg was the first Russian city built in imitation of western European cities. Its magnificent palaces, handsome public buildings, and wide public squares resemble those of such cities as London, Paris, and Vienna. In the early 1800's, a commission that included noted Italian architect Carlo Rossi established a design for the center of the city that includes a series of squares.

The city has had three names. Czar Peter I (the Great) founded it in 1703 as St. Petersburg. After Russia went to war against Germany in 1914, at the start of World War I, the name was changed to Petrograd. The country's officials chose this name, which means *Peter's City* in Russian, to get rid of the German ending *burg.* In 1922, the Soviet Union was formed under the leadership of Russia. In 1924, the Soviet Union's Communist government renamed the city in honor of V. I. Lenin, the founder of the Soviet Communist Party. In 1991—as Communist influence in the Soviet Union declined—the people of the city voted in a nonbinding referendum to restore the name St. Petersburg. In September 1991, the Soviet government officially approved the name change. In December 1991, the Soviet Union was dissolved, and Russia became an independent nation.

The city lies on a marshy lowland where the Neva River empties into the Gulf of Finland, at about 60° north latitude. Because of its far northern location, St. Petersburg has very short periods of daylight in winter. For about three weeks in June, it has "white nights," during which the sky is never completely dark.

The center of St. Petersburg is on the southern bank of the Neva. This area includes the main business district and most of St. Petersburg's famous buildings. Many fine examples of baroque and neoclassical architecture have been preserved in the area, and few modern structures have been built there. The city has about 900 small rivers and canals and about 400 bridges.

The historic Winter Palace, which was completed in 1762 and is now part of the State Hermitage Museum, stands in the center of the city. The palace was the winter home of the czars. The General Staff Building, designed by Rossi and completed in 1829, stands across Palace Square from the Winter Palace. Several blocks away is the Cathedral of St. Isaac of Dalmatia, whose massive golden dome dominates St. Petersburg's sky-



Tom Tracy, Black Star

Huge crowds jam St. Petersburg's main street, Nevsky Prospekt. Many fine restaurants and shops line the street.

Vance Henry, Taurus

A luxurious palace built during the 1700's still stands in Petrodvorets, a suburb of St. Petersburg. Hundreds of fountains beautify the grounds of the palace, which was the summer residence of several Russian czars.

line. The Peter and Paul Fortress, begun in 1703, is the oldest building in St. Petersburg. Many Russian czars are buried in a cathedral at the fortress.

The center of St. Petersburg is surrounded by old residential areas that have stone or brick apartment buildings. Near the outskirts of the city are thousands of modern concrete apartment buildings. The western section of St. Petersburg is the chief industrial district of the city.

Several luxurious palaces built in the 1700's still stand in three suburbs of St. Petersburg—Pavlovsk, Petrodvorets, and Pushkin. These palaces, famed for their architectural excellence, were summer homes of the czars. Today, they are popular resorts and tourist attractions.

Education and cultural life. Over 40 institutions of higher learning are in the city. St. Petersburg University is one of Russia's largest universities. The Conservatory of Music, established in 1862, is the nation's oldest music school. Its graduates include such famous composers as Sergei Prokofiev, Dimitri Shostakovich, and Peter Ilich Tchaikovsky. The Choreographic School trained such famous ballet dancers as Vaslav Nijinsky, Rudolf Nureyev, and Anna Pavlova.

St. Petersburg is the home of many fine museums and theaters. The Hermitage, Russia's largest museum, is known worldwide for its masterpieces. It exhibits outstanding collections of ancient Greek and Roman sculpture; Islamic art; and Baroque, Renaissance, and French Impressionist paintings. The Russian Museum has a large collection of Russian art. The Kirov Theater presents ballet and opera. Several theaters, including the Gorki Academic Theater, the Pushkin Theater, and the Young Spectators' Theater, offer dramatic productions.

The city has an important place in Russian literature. A number of famous Russian authors have used St. Petersburg as a background for many of their works. These writers include Alexander Pushkin, Fyodor Dostoevsky, and Andrey Bely.

The people. Most St. Petersburgers are members of the Russian nationality, or ethnic, group. Jews and Ukrainians are the city's largest minority groups.

Few St. Petersburgers own automobiles, but the city has an efficient public transportation system of buses, streetcars, and subway and commuter trains. The city has such problems as air pollution and overcrowding. But it has far less crime than many cities of similar size.

Economy. St. Petersburg has been a major shipbuilding center since the early 1700's. During the 1800's, it became an important manufacturer of machine tools. Today, the production of machinery makes up about 40 percent of the city's industry. Other important products include chemicals, electrical equipment, textiles, nuclear reactors, and timber.

St. Petersburg's industry and location make it an important trade and distribution center. The city has an excellent port and is served by 12 railroads.

History. Peter the Great founded the city as St. Petersburg in 1703. He had visited Western Europe and wanted to bring Western culture and technology to Russia. He made St. Petersburg his "window to the West," a showcase for his efforts to Westernize Russian life. Western architects played an important role in the city's construction. In 1712, Peter moved the nation's capital from Moscow to St. Petersburg. The new capital soon became the intellectual and social center of the Russian Empire. By 1800, over 220,000 people lived in the city.

The city played an important part in many major events in Russian history. In 1825, an unsuccessful uprising against Czar Nicholas I took place there. In 1881, a group of Russian revolutionaries assassinated Czar Alexander II in St. Petersburg. Early in 1905, troops of Czar Nicholas II killed or wounded hundreds of unarmed demonstrators in front of the Winter Palace. This *Bloody Sunday* slaughter led to the Revolution of 1905.

The city's name was changed to Petrograd in 1914. Riots and strikes occurred there during the Revolution of 1917, which ended czarist rule in the country. Late that year, Bolshevik (Communist) forces seized the city and formed a new government, headed by Lenin. The Bolsheviks moved the capital back to Moscow in 1918. In 1922, Russia and three other republics united to form the Soviet Union. Petrograd was renamed Leningrad upon Lenin's death in 1924.

In 1934, a Communist Party leader named Sergey Kirov was assassinated in Leningrad. His murder touched off the *Great Purge,* during which the government's secret police killed or imprisoned millions of people. During World War II (1939-1945), Leningrad was a major target of Germany's attack on the Soviet Union. The Germans laid siege to the city from September 1941 to January 1944. Historians estimate that about 1.7 million Soviet people may have died in and around Leningrad, most of them from starvation, during the siege of nearly 900 days. The city was badly damaged by the attack, but it did not fall.

A large number of the city's historic structures were rebuilt after World War II. The city also carried out construction projects to overcome a severe housing shortage. Large numbers of apartment buildings were constructed to meet the needs of the city's growing population. In 1966, city officials adopted a long-range program aimed at achieving a better distribution of housing, office buildings, and parks.

In the late 1980's the Communist Party's tight control of the Soviet Union began to break up. As a result of elections held in 1990, non-Communists won control of Leningrad's government. In August 1991, conservative Communist officials attempted to take over the Soviet national government. More than 130,000 people turned out in Leningrad to demonstrate their opposition to the coup. The coup failed within days, unleashing anti-Communist sentiments throughout the nation. In September 1991, the city's Communist name of Leningrad was changed back to the original St. Petersburg. In December 1991, the Soviet Union was dissolved. Russia and other former Soviet republics became independent nations. Jaroslaw Bilocerkowycz

See also Leningrad, Siege of.

Saint Petersburg (pop. 248,232) is a city on the west coast of Florida. Its warm, sunny climate and location on Tampa Bay made the city a resort area, beginning in the early 1900's. St. Petersburg is sometimes called the *Sunshine City* because of its pleasant weather. In the mid-1900's, many retired people began moving to St. Petersburg, and the city became a retirement center as well. In the late 1900's, a variety of new economic opportunities attracted many younger people to the area to work.

St. Petersburg lies at the tip of Pinellas Peninsula on Tampa Bay (see Florida [political map]). St. Petersburg

and Tampa, which lies across the bay, form part of a metropolitan area that has a population of 2,395,997. See Tampa.

Description. St. Petersburg covers about 59 square miles (153 square kilometers). Three bridges link the city with the Florida mainland to the east. Other bridges and highways connect the city with heavily developed barrier beach islands on the Gulf of Mexico to the west. The city has about 40 miles (64 kilometers) of shoreline and a deepwater harbor that is home to a United States Coast Guard base. St. Petersburg has about 70 lakes. Because of its climate and location, St. Petersburg is a center for such water sports as fishing, sailing, and scuba diving.

The city's chief cultural attractions and recreation areas lie on Tampa Bay, just east of downtown. The city has a number of museums. One of them, the Dali Museum, houses what may be the world's most comprehensive collection of works by the Spanish artist Salvador Dali. Bayfront Center and The Pier provide cultural or recreational facilities. Bayfront Center has a performing arts theater, a sports arena, and convention facilities. The Pier extends into Tampa Bay and includes restaurants, shops, and an aquarium. St. Petersburg is the home of Eckerd College, a branch campus of the University of South Florida, and St. Petersburg Junior College.

Several major-league baseball teams have held spring training in St. Petersburg since 1914. As a result, the city is called the *Winter Baseball Capital of the United States.* The city gained a major-league baseball team of its own in 1998, when the Tampa Bay Devil Rays of the American League began playing at Tropicana Field.

Economy. St. Petersburg is a leading medical center. Health care ranks as a major employer in the area. Retail trade and manufacturing are also important employers. The chief manufactured products include electronic equipment and health care products. Spending by tourists contributes heavily to the area's economy.

Government and history. St. Petersburg has a strong-mayor form of government. A city council makes government policies. It consists of a mayor and eight council members, all elected by the people to four-year terms. The mayor hires a city administrator, who handles the day-to-day operations of the government.

Indians lived in what is now the St. Petersburg area as early as 5000 B.C. Timucuan Indians lived there when Spanish explorers first arrived in the early 1500's. Whites began to settle there in the 1840's. Peter A. Demens, a Russian-born businessman, built a railroad to the area from central Florida. Demens named the community for his birthplace, St. Petersburg, Russia. By 1890, about 270 people lived in St. Petersburg. The community was incorporated as a town in 1892 and as a city in 1903.

The first of several tourist booms in St. Petersburg began in the early 1900's. The city attracted attention in 1914, when the world's first commercial airline began to operate there. A boom in land sales increased the population from 14,000 in 1920 to about 40,000 in 1930. Gandy Bridge, which opened in 1924, linked St. Petersburg and Tampa. Later, other bridges helped the city's growth.

St. Petersburg has built several projects on Tampa Bay. The St. Petersburg Yacht Basin, a harbor for yachts, opened in 1963. Bayfront Center opened in 1965 and was modernized in 1988. The Pier was renovated in 1973 and 1988. The Vinoy Park Hotel, built on the waterfront during the 1920's land boom, was restored and reopened as a luxury hotel in 1992. Susan Taylor Martin

Saint-Pierre and Miquelon, *MIHK uh lahn,* are two small French islands located off the southern coast of the island of Newfoundland. They lie about 15 miles (24 kilometers) to the west of Burin Peninsula (see **Newfoundland and Labrador** [political map]). The rocky islands cover a total area of 93 square miles (242 square kilometers) and have a population of about 7,000. They are ruled by an administrator who is assisted by a *privy council,* made up of chiefs of departments. The *general council,* made up of 14 elected members, manages financial and other local affairs. The two islands and several small islet dependencies make up a political unit of France called a territorial collectivity.

The islands are an important base for French fishing operations. They also draw many summer tourists. St.-Pierre, the capital and largest town, has a good harbor.

France first occupied the islands in 1635. England and France controlled them in turn until 1814, when France took final possession. In 1956, the French government gave them self-government. Simon M. Evans

Saint-Saëns, *san SAHNS,* **Camille,** *ka MEE yuh* (1835-1921), was a French composer. His most famous work is *The Carnival of the Animals* (1886) for two pianos and orchestra. His other major compositions include the Cello Concerto No. 1 (1873), the Piano Concerto No. 4 (1875), the opera *Samson and Delilah* (1877), and the chamber work *Septet* (1880).

Charles Camille Saint-Saëns was born on Oct. 9, 1835, in Paris. He was a child prodigy, composing several pieces for piano by the age of 5 and making his debut as a pianist at the age of 10. In 1871, he helped found the Société Nationale de Musique to encourage new French music. Under his leadership, the Société introduced the works of such French composers as Claude Debussy, Vincent D'Indy, Gabriel Fauré, and César Franck. Saint-Saëns was also an accomplished pianist and organist. Vincent McDermott

Saint-Simon, *san see MAWN,* **Comte de,** *kawnt duh* (1760-1825), was a founder of French socialism. His ambition was to better humanity. He wanted to bring about a new society in which all people would have to work and would receive rewards equal to their labor. No person would be allowed to inherit wealth, and all individuals would start life on an equal basis. Saint-Simon wanted to base his social theories on scientific evidence, but actually his conclusions were unsystematic.

Saint-Simon was born on Oct. 17, 1760, in Paris. He went to America in his youth and fought in the Revolutionary War. He took no active part in the French Revolution, though he welcomed it. His given and family name was Claude Henri de Rouvroy. W. T. Jones

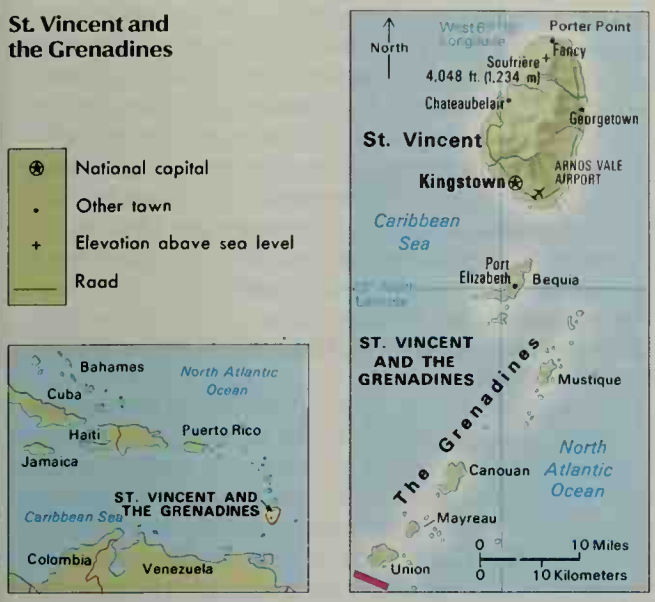
Saint Sophia. See Hagia Sophia.

Saint Thomas. See Virgin Islands.

Saint Valentine's Day. See Valentine's Day.

Saint Valentine's Day Massacre. See Chicago (The Roaring Twenties).

Saint Vincent and the Grenadines, *GREHN uh DEENZ,* is a small island country in the West Indies. It lies in the Caribbean Sea, about 200 miles (320 kilometers) north of Venezuela. The country consists of the island of St. Vincent and about 100 small islands of the Grenadine chain, including Bequia, Canouan, Mayreau,

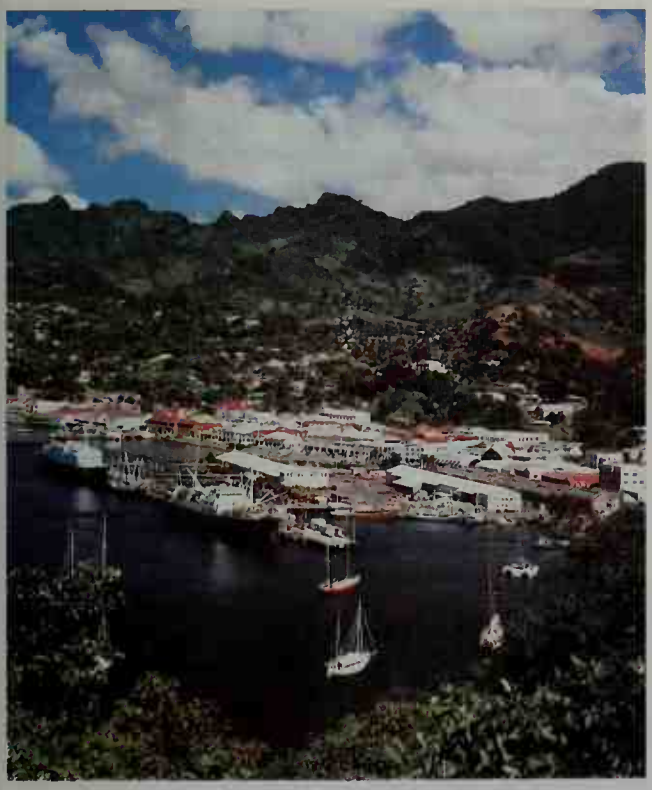


WORLD BOOK maps

Mustique, and Union. It has a total land area of 150 square miles (388 square kilometers) and a population of about 116,000.

St. Vincent and the Grenadines became independent in 1979 after being ruled by Britain since 1783. Kingstown, on the southern coast of St. Vincent, is the capital and largest city. The basic unit of money is the East Caribbean dollar. For a picture of the nation's flag, see **Flag** (Flags of the Americas).

Government. St. Vincent and the Grenadines is a constitutional monarchy and a member of the Commonwealth of Nations (see **Commonwealth of Nations**). A prime minister runs the government with the aid of a Cabinet. A one-house Parliament, which has 15 representatives and 6 senators, makes the country's laws. The people elect the representatives. The governor general, a symbolic official appointed by the British monarch, appoints the senators. The head of the political party with the most seats in Parliament serves as prime minister.



J. Alex Langley, DPI

St. Vincent and the Grenadines is a country in the Caribbean Sea. Its capital, Kingstown, has a beautiful harbor, shown here.

People. Most of the people of St. Vincent and the Grenadines are descendants of black African slaves. British and French settlers brought the slaves to the islands. Nearly half of the people live in urban areas, and the rest live in rural localities.

English is the official language of St. Vincent and the Grenadines. However, many people chiefly speak a *patois* (dialect) that is a mixture of African languages and French. About half of the people are Anglicans. Other religious groups include Methodists and Roman Catholics.

Land and climate. St. Vincent and the Grenadines is a mountainous country that was formed by volcanic eruptions. Tropical vegetation covers much of the land. Mount Soufrière, an active volcano on the northern end of St. Vincent, is the country's highest point. It rises 4,048 feet (1,234 meters). Temperatures in the country seldom rise above 90 °F (32 °C) or fall below 65 °F (18 °C). The annual rainfall ranges from 60 inches (150 centimeters) on the southeast coast of St. Vincent to 150 inches (381 centimeters) in the island's central mountains.

Economy of St. Vincent and the Grenadines is based on agriculture. Most of the people work on farms. The main export crops include bananas and coconuts. The country is the world's leading producer of arrowroot, a plant whose roots are made into starch. Fishing, manufacturing, and tourism are minor economic activities in St. Vincent and the Grenadines.

History. Arawak Indians were the first inhabitants of what became St. Vincent and the Grenadines. They were conquered about 1300 by the Carib Indians of South America. Britain took control of the islands in 1783. Until that time, the Carib, the British, and the French had fought one another for the islands. During the struggle, the British and French had imported slaves from Africa to work on the plantations. The Carib continued to fight the British until the mid-1790's, when their revolt was crushed. Slavery was abolished in St. Vincent and the Grenadines in 1833.

St. Vincent and the Grenadines gradually gained freedom from Britain. It became independent on Oct. 27, 1979. In December 1979, police put down a minor revolt on Union Island by a group that wanted more power in the country's new government. In 1983, St. Vincent and the Grenadines and several other Caribbean nations joined the United States in an invasion of Grenada to overthrow a Marxist government there. See **Grenada** (History and government) for details.

Gerald R. Showalter

See also **Kingstown**.

Saint Vitus's dance. See **Chorea**.

Sainte-Anne-de-Beaupré, *boh PRAY,* is a Roman Catholic shrine in Montmorency County, Quebec. It is a place where many miracles are said to have been performed. Hundreds of thousands of ill and disabled men and women have made pilgrimages to the shrine. Hundreds have left their crutches in the church as tokens of their healing.

E. C. Carle, Shostal

The basilica of Ste.-Anne-de-Beaupré is a Roman Catholic shrine in Montmorency County in the province of Quebec.

An old legend tells how the first chapel was built there during the early days of French settlement in Canada. A boatload of Breton sailors was being tossed about wildly by the waves on the St. Lawrence River. The sailors prayed to Saint Anne, the patron saint of sailors. They promised to build a chapel in her honor if they were saved. After the storm, they landed where the Ste.-Anne du Nord River joins the St. Lawrence near Quebec. There they built a chapel in 1658.

In 1661, a church was built on the site. In 1876, a new church was built nearby. It was later designated a basilica by the pope. A fire destroyed the structure in 1922. But a priest aided by parishioners saved the relic of Saint Anne and the statue of the saint. The basilica has since been rebuilt and is now the largest pilgrimage center in Canada. Critically reviewed by the Redemptorist Fathers of the Basilica of Ste.-Anne

See also **Quebec** (picture: The basilica of Sainte-Anne-de-Beaupré).

Sainte-Beuve, *sant BUHV,* **Charles Augustin,** *shahrl oh goo STAN* (1804-1869), a French critic, was the greatest exponent of the biographical method of literary criticism. His works reveal that his main interest was in human psychology and the origin of a literary work in the creator's mind, family, friends, and time.

Sainte-Beuve possessed excellent taste and tireless curiosity. Writing in a delicate, subtle style, he covered the entire field of arts and letters, and probably did more than any other person to determine attitudes on French literature in his time. His brilliant essays were published in *Literary Portraits* (1829-1846), *Contemporary Portraits* (1846), 15 volumes of *Monday Chats* (1853-1862), and 10 volumes of *More Monday Chats* (1863-1872).

Sainte-Beuve was also an outstanding historian of French aesthetic and intellectual movements. *Tableau of French Poetry* (1828) is a sympathetic study of the French origins of romanticism. *History of Port-Royal* (1840-1860) examines Port-Royal, a French convent that became the center of a religious and literary movement in the 1600's. *Chateaubriand and His Literary Circle* (1860) is a critical assessment of the French statesman and author and his literary circle during the First Empire in the early 1800's. Sainte-Beuve also wrote poetry and a partly autobiographical novel, *Volupté* (*Pleasures of the Senses,* 1834).

Sainte-Beuve was born in Boulogne-sur-Mer. He spent much of his career writing for newspapers and for literary magazines. Thomas H. Goetz

Saintpaulia. See African violet.

Saints Peter and Paul, Cathedral of. See Washington Cathedral.

Saipan, *sy PAN,* is the capital and largest island of the Northern Mariana Islands, in the central Pacific Ocean. It lies about 1,600 miles (2,570 kilometers) east of Luzon Island in the Philippines, and about the same distance southeast of Tokyo (see Northern Mariana Islands, Commonwealth of the [map]). Saipan has an area of 48 square miles (124 square kilometers) and a population of about 39,000. Its largest town, Garapan, was destroyed in World War II (1939-1945), but has since been rebuilt. Garapan has the best harbor in the Northern Marianas.

Saipan belonged to Spain until 1899, when Germany bought it. A mandate of the League of Nations gave Japan control after World War I (1914-1918). The Japanese planted sugar cane, and built large sugar refineries and heavy fortifications on the island. Saipan was the scene of heavy fighting during World War II. United States forces landed there in June 1944, and captured the island after several weeks of fierce fighting. Saipan then became an important U.S. air base for further attacks on Japan. After the war, the Northern Marianas, including Saipan, became part of the United Nations Trust Territory of the Pacific Islands under U.S. control. In 1986, the Northern Marianas became a self-governing commonwealth of the United States. Today, tourism is an important economic activity in Saipan.

Robert C. Kiste

Sakakawea. See Sacagawea.

Sakhalin, *SAK uh LEEN,* is a long island of Russia, off the east coast of the country's mainland. It is about 600 miles (970 kilometers) long and from 16 to 100 miles (26 to 160 kilometers) wide. It has 709,000 people and an area of 29,460 square miles (76,300 square kilometers). For location, see **Russia** (terrain map).

Pine and spruce forests cover almost all of Sakhalin. It has a changeable climate and the land is not suited to farming. Most of the people make a living by fishing, and fish is their most important food. Many fur-bearing animals live on the island, and some of the people are fur traders. Other industries include lumbering and the manufacture of wood pulp. The island is also a source of coal, oil, and natural gas.

Dutch navigators were the first to discover Sakhalin. For many years Russia and Japan quarreled over the island. In 1875, Japan recognized Russia's ownership. But disputes continued until 1905, when Russia and Japan divided Sakhalin between them. Russia took the northern half of the island, and Japan took over the southern half. The Ainu, a group of people who may have been the first inhabitants of Japan, lived on Sakhalin until the mid-1900's. The discovery of oil on Sakhalin led the Soviet Union to colonize it in 1931. The Soviet Union had

been formed in 1922 under Russia's leadership. The defeat of Japan in World War II (1939-1945) gave the Soviet Union complete control of the island. In 1991, the Soviet Union was dissolved, and Russia took control of the island. Craig ZumBrunnen

Sakharov, *SAHK uh rawf,* **Andrei Dmitriyevich,** *uhn DRYAY ih duh MYEE tryih yuh vyihch* (1921-1989), was a Soviet physicist who gained prominence for his research on controlled thermonuclear reactions. His work helped scientists in the Soviet Union develop a hydrogen bomb in the early 1950's. However, Sakharov became best known for his efforts to promote human rights and world peace.

Yelena Bonner, Gamma/Liaison

Andrei Sakharov

He received the 1975 Nobel Peace Prize for those efforts. Beginning in the late 1960's, Sakharov and his wife, Yelena Bonner, repeatedly criticized the Soviet government, charging that it denied Soviet citizens basic human rights. In 1980, the Soviet authorities arrested Sakharov and exiled him from Moscow to Gorki (now Nizhniy Novgorod), an industrial center closed to foreigners. In 1986, Sakharov was released from exile and he returned to Moscow. In 1989, he was elected to the newly formed Soviet legislature called the Congress of People's Deputies. He described his life as a scientist and his struggle against Soviet authority in his *Memoirs* (published in 1990, after his death). Walter C. Clemens, Jr.

Saki. See Munro, Hector Hugh.

Saladin, *SAL uh dihn* (1138-1193), was the best-known Muslim warrior of the 1100's. He brought about the Third Crusade by capturing Jerusalem in 1187 (see **Crusades** [The Third Crusade]). The Muslims regarded Saladin as a saintly hero, and even the Christians honored him for his honesty and bravery.

Saladin was a soldier in the army of Syrian leader Nur al-Din. In 1164, Nur al-Din sent Saladin with an army to settle a struggle between members of the government of Egypt. The army returned to Egypt in 1168 to defend against Christian crusaders. The Syrians took control of Egypt, and Saladin became *vizier.* The vizier led the government, though the head of state was the caliph.

The caliph of Egypt was leader of the Shiite branch of Islam, and thus a rival of the caliph of Baghdad, leader of the Sunni branch (see **Islam** [Divisions of Islam]). Before the Egyptian caliph died, in 1171, Saladin ordered Egypt to join the Sunni branch. The caliph of Baghdad later recognized Saladin as sultan of Egypt and Syria.

After gaining control of Egypt, Saladin extended his rule northeastward to Damascus, Aleppo, Mosul, and Edessa. He led Muslim armies that captured Jerusalem from the Christians in 1187. Some of his troops were besieged at Acre (now Akko) in 1189. They surrendered after two years to Richard the Lion-Hearted (see **Richard I**). Saladin and Richard made a truce in 1192 that gave the coast to the Christians and the interior to the Muslims and allowed Christian pilgrims to enter Jerusalem.

Saladin supported theologians and other scholars. He also built schools, dikes, canals, and mosques. Saladin was born in Mesopotamia. George Giacumakis, Jr.

Salamander is a timid, harmless animal that looks like a lizard but is related to frogs and toads. It is a type of amphibian (see **Amphibian**). Salamanders live on all the continents except Antarctica and Australia. They are most common in Asia, Europe, and North America.

There are more than 400 species of salamanders, making up 10 families. The species include hellbenders; mudpuppies; newts; and marbled, red-backed, spotted, and tiger salamanders. Most salamanders are only a few inches or centimeters long, but the *giant salamander* of China and Japan can grow as long as 5 feet (1.5 meters).

Most salamanders mate and lay their eggs in water, but otherwise live on land. They tend to dwell in cool, dark, moist places, such as rotten logs. However, mudpuppies and some other species spend their whole lives in water, and a few species never enter water at all.

The body of a salamander. Most salamanders have moist, dark skin and are hard to see in their natural envi-

WORLD BOOK illustration by John F. Eggert

The red salamander lives in the eastern United States.

WORLD BOOK illustration by Richard Lewington

Spotted salamanders are common in moist woodlands.

ronment. A number of species, however, are brightly colored. Some of these species secrete a milky fluid through the skin when handled roughly or when in danger. This fluid is poisonous to some animals.

Salamanders have a long tail that is used for swimming. Most species have four legs, but a few that live in water lack hind legs. Salamanders possess a strong sense of smell, and most have a long, sticky tongue for catching food. They eat mainly worms and insects.

The life of a salamander. Like all amphibians, salamanders are *cold-blooded*—that is, their body temperature remains close to that of their environment. During cold periods, they burrow into soil or lie on a pond bottom, where they are generally inactive. Species that live in mountain streams and springs may stay active all year.

Many salamanders perform an elaborate courtship dance before mating. After the dance, male salamanders produce a *spermatophore,* or jellylike packet of sperm. The female picks up the spermatophore, which internally fertilizes her eggs. Female salamanders lay eggs in water or on moist ground. Eggs laid in water usually hatch in a few weeks, but those laid on land may require several months to develop fully. In many species, the female stays with her eggs until they hatch. During this period of care, called *brooding,* the female does not eat.

Newly hatched salamanders are called *larvae.* They resemble frog tadpoles, but have feathery gills at the sides of their heads. The larvae change into adults through a process called *metamorphosis,* which lasts from 42 days to 5 years, depending on the species. During this time, features of the larvae may disappear. For example, most salamanders lose their larval gills just before becoming adults. Many salamanders breathe with lungs as adults. But the largest salamander family is lungless, and adults breathe primarily through their skin. Don C. Forester

Scientific classification. Salamanders belong to the class Amphibia and make up the order Caudata.

See also Mudpuppy; Newt.

Salamis, *SAL uh mihs* or *SAH lah MEES,* is a Greek island in the Saronic Gulf, about 10 miles (16 kilometers) west of Athens (see Greece [political map]). It covers 37 square miles (95 square kilometers) and has 28,500 people. Much of the land is rocky, mountainous, and lacking in vegetation. Most of the people commute to jobs in Athens or work in the island's shipping industry. Some farmers grow vegetables and grapes. Because the island has an irregular crescent shape, Salamis is also known as *Koulouri,* which means *baker's crescent.*

The Greeks and Persians fought a great sea battle near Salamis in 480 B.C. When the Persians advanced after the Battle of Thermopylae, the Athenians sought safety on Salamis. In the Battle of Salamis, Persian ships tried to block the retreat of Greek vessels. The Greeks destroyed half the Persian fleet. John J. Baxevanis

See also Aristides; Themistocles; Xerxes I.

Salazar, *sal uh ZAHR,* António de Oliveira, *an TAW nyoo duh aw lee VAY ruh* (1889-1970), served as prime minister of Portugal from 1932 to 1968. He ruled as a virtual dictator after proclaiming a new constitution in 1933. He called his government the *Estado Novo* (New State).

Salazar was born on April 28, 1889. He served as a professor of economics at the University of Coimbra and then became Portugal's finance minister in 1928. The military dictatorship gave him broad powers to overhaul the nation's weak economy. Salazar's powers gradually increased until, by 1929, he had emerged as the most powerful figure in the government.

Salazar's policies quickly turned the debt created by previous governments into budget surpluses. His government invested the extra money in an ambitious plan to improve Portugal's industries and services. The plan brought electric power and new schools to rural areas, built new roads, and created a national airline. It had little effect, however, on the low standard of living of most Portuguese people. Salazar kept Portugal neutral in World War II (1939-1945). But he yielded to pressure to grant the Allies bases in the Azores, a Portuguese island group in the North Atlantic Ocean.

After the war, Salazar's policies brought economic stagnation and political repression to Portugal. Many Portuguese left the country. Salazar's refusal to grant freedom to Portugal's colonies led to military confrontations. In 1961, Indian forces captured the last of three small Portuguese colonies in India. Fighting also occurred in Portugal's African colonies—Angola, Guinea (now Guinea-Bissau), and Mozambique. It killed many people and severely strained Portugal's economy.

Salazar left office after suffering a stroke in 1968 and was replaced as prime minister by Marcello Caetano. By that time, Portugal was considered one of the most backward nations in Europe. Salazar died on July 27, 1970. Douglas Porch

Sale, Bill of. See Bill of sale.

Salem, *SAY luhm,* Massachusetts (pop. 40,407), is one of New England's most historic cities. It was the site of the famous witchcraft trials of the 1690's. Around 1850, it became a cotton industry center. Today, its products include adhesives, electronic equipment, industrial chemicals, leather products, optical instruments, and plastics.

Location and description. Salem lies on a fine harbor, 16 miles (26 kilometers) northeast of Boston. For location, see Massachusetts (political map).

Salem State College is in Salem. The city's many historic houses include the birthplace of Nathaniel Hawthorne; the House of Seven Gables, about which he wrote his famous novel; and the Custom House, where he worked from 1846 to 1849. Beautiful homes built by

Ellis Herwig, Stock, Boston

The Custom House, in Salem, Massachusetts, is one of the city's best-known historic buildings. It was built in 1819.

wealthy sea merchants line Chestnut and Federal streets.

The Essex Institute and the Peabody Essex Museum in Salem have preserved many relics from the voyages of Salem ships. The Salem Maritime National Historic Site, which covers 10.73 acres (4.34 hectares), features buildings that were significant in the maritime, architectural, and literary history of New England. The first settlement in Salem has been reconstructed as Pioneer Village. Another historic site is the Witch House, where preliminary hearings for the witchcraft trials were held.

History. Roger Conant and colonists from Cape Ann established the first settlement on the site of Salem in 1626. In 1628, John Endecott led a group of settlers into the area for the New England Company (later named the Massachusetts Bay Company).

Salem's witchcraft scare began in 1692. A West Indian slave named Tituba and two other women were accused of being witches. Tituba was freed after 13 months in jail, one woman died in jail, and the other one was executed. The witchcraft scare continued for about a year. Nineteen people were hanged as witches on Gallows Hill, and one was pressed to death for refusing to plead to the witchcraft charge. See **Salem witchcraft trials; Sewall, Samuel; Witchcraft.**

During the Revolutionary War in America (1775-1783), Salem became a great privateering port. When peace came, Salem merchant ships sailed all over the world. Salem captains traveled around the Cape of Good Hope to reach the Far East. Salem again was a privateering port in the War of 1812. But war losses, the increasing shallowness of the harbor, and the opening of the Erie Canal ruined the trade.

Salem received its city charter in 1836. It has a mayor-council form of government. Laurence A. Lewis

Salem, *SAY luhm* (pop. 136,924; met. area pop. 347,214), is the state capital and one of the largest cities of Oregon. The city lies in the Willamette Valley in northwestern Oregon. For location, see **Oregon** (political map).

Salem serves as an important commercial center for surrounding farm communities. About 60 state government agencies make up the largest source of employment in Salem. Other major employers include food processing businesses and retail services.

The city is the home of Willamette University and Western Baptist College. Willamette University is the oldest university west of the Rocky Mountains. It was founded in 1842 as the Oregon Institute. Tourist attractions in Salem include a number of restored houses built in the 1800's. One of these is the Bush House, a mansion furnished with antiques. The Mission Mill Museum offers tours of four other restored houses.

Salem was founded in 1840 as a missionary settlement by Jason Lee, a Methodist missionary. *Salem* is the English version of *Shalom,* a Hebrew word meaning *peace.* In 1851, the community took the name *Salem* and became the state capital. It is the seat of Marion County and has a council-manager government. H. Peter Eilers

Salem, Peter (1750?-1816), was a former black slave who fought in the Battle of Bunker Hill. The battle, actually fought at nearby Breed's Hill, was one of the first military conflicts of the Revolutionary War in America. It was fought on June 17, 1775, near Boston.

In the battle, British forces attacked colonial troops who were defending Breed's Hill. According to one story, the colonial troops were near defeat, and British Major John Pitcairn ordered them to surrender. Salem then stepped forward and shot Pitcairn. The British were temporarily stunned, and the Americans were able to retreat. Pitcairn later died of the wound.

Salem was born a slave in Framingham, Massachusetts. His original owner was Jeremiah Belknap. Belknap sold him to Lawson Buckminister of Framingham. Buckminister allowed Salem to enlist in the colonial army. In exchange for enlisting, Salem received his freedom. After the Battle of Bunker Hill, Salem served in the colonial forces until the end of the war. He died on Aug. 16, 1816. Alton Hornsby, Jr.

Salem witchcraft trials were trials that resulted from the largest witch hunt in American history. The trials were held in 1692 in Salem, a town in the Massachusetts Bay Colony. Nineteen people, both men and women, were convicted and hanged as witches. Another man was pressed to death with large stones for refusing to plead innocent or guilty to the witchcraft charge. About 150 other people were imprisoned. The Salem trials resulted in the last witchcraft executions in America.

The Massachusetts Bay Colony was an English colony, and many people there had brought the belief in witchcraft from England. Under English law, witchcraft was punishable by death. Sixteen people had been hanged as witches in New England before 1692.

The Salem trials occurred as a result of a witch hunt that began nearby in the small farming community of Salem Village (now Danvers, Massachusetts). Early in 1692, several village girls began to behave strangely. They crawled under tables, uttered weird sounds, and screamed that they were being tortured. Suspicions of witchcraft soon led to the arrest of three women. More arrests followed. They included prominent people, such as a former village minister and the wife of the wealthiest merchant in the town of Salem.

Some historians believe a dispute over a local minister, Samuel Parris, led to the witch hunt. Parris received much support from the poorer farmers of Salem Village. To them, Parris and the village church represented stability and traditional values. These farmers saw Salem, with its increasingly important merchants, as a threat to their way of life. Parris and his supporters helped lead the witch hunt. Many villagers who opposed Parris or had links with Salem were arrested as witches. The scare lasted about a year. The colony's leading ministers helped stop it. In 1693, the people still in jail on witchcraft charges were freed. In 1711, the colony made payments to the families of witch-hunt victims. Paul Boyer

See also **Sewall, Samuel; Witchcraft** (History).

Sales is the business of selling goods or services. Often referred to as *personal selling,* sales involves communicating with potential customers, informing them about certain products, and persuading them to buy. Most companies employ *salespeople* to handle sales efforts. Many other people—including secretaries, mechanics, and executives—also help sell a company's products.

Sales is one of the most important business activities. A company cannot earn money unless people buy its products. An effective sales force benefits other people in the company. The more the company sells, the more it needs to produce or provide. Increased production, in turn, creates jobs and benefits the economy as a whole.

Sales is just one part of a process called *marketing.* Other steps in the marketing process include market research, product development, pricing, and advertising. Advertising and sales are similar because both operations are aimed at trying to persuade people to buy products. But advertising and other forms of *sales promotion* are generally aimed at a wide audience. Sales, on the other hand, involves two-way communication between a salesperson and a customer. Personal selling efforts enable the buyer to ask questions about a product and to receive additional information about it immediately. Through advertising, a company can reach large numbers of people. But personal selling is more effective at persuading individuals to buy.

Sales has been practiced for thousands of years, and it has played an important role in the economic development of many nations. Through the centuries, salespeople have helped persuade people to buy new and better products. For example, many people balked at purchasing automobiles and television sets when they were introduced. But after extensive efforts to sell those inventions, they became widely accepted.

Kinds of selling

Consumers, both individuals and organizations, buy products chiefly from shops, supermarkets, department stores, and other *retailers.* However, in many cases, a product is bought and sold several times before a consumer finally purchases it. Typically, manufacturers sell products to business firms called *wholesalers,* who sell the goods to retailers. The retailers, in turn, sell the products to consumers.

Selling by manufacturers. Manufacturers generally use salespeople to sell their products to other manufacturers, to wholesalers or distributors, or to retailers. Some manufacturers sell directly to customers who purchase products in large amounts. Sales representatives for a manufacturer must have thorough technical knowledge of the items they sell. They also must know their company's prices, terms of delivery, and other policies.

Wholesaling. Wholesalers generally sell products to retailers and to large-volume customers, such as industrial corporations. Most wholesalers buy products from a number of manufacturers and concentrate on assembling brands in one category of product. For example, a grocery wholesaler might buy cornflakes, shredded wheat, and other breakfast cereals from several makers.

Most wholesalers employ sales representatives who travel to retail stores. These salespeople provide information on their products and try to persuade retailers that those products will appeal to consumers. Wholesalers must know what items the store needs, the brands that are available, and the terms under which the products are sold.

Unlike retail salespeople, who usually deal with one buyer at a time, sales representatives for wholesalers and manufacturers may have to persuade several individuals in a business to buy the product. In a department store, for example, the funds available to buy clothing may be split between the men's clothing buyer and the women's clothing buyer. The salesperson who sells clothing to the store may have to please both buyers before a single sale can be completed.

In some cases, the sales agent must persuade members of a *buying committee* to choose the product. Some members may be concerned chiefly with how customers in their own department will react to the product. Others may be more interested in reducing the price. In such cases, the salesperson must gear the sales approach to satisfy all members of the committee.

Retail selling. Retailers sell directly to final consumers. Unlike salespeople for manufacturers and wholesalers, most retail salespeople do not usually call on their customers. Many work in stores and wait for people to come to them. They help customers chiefly by answering their questions. Retail salespeople need to know what products the store carries, where to find them, and how much they cost. They must also know how to operate a cash register, handle money and make change, and wrap packages.

Other types of selling. Some salespeople sell to consumers by going to potential customers' homes or offices. Insurance, for example, is sold in this way by people called *insurance agents.* Many houses are bought and sold with the help of salespeople known as *real estate agents.* Salespeople called *stockbrokers* help people buy and sell stocks. Stockbrokers and other financial services salespeople conduct much of their business over the telephone and the Internet. Other salespeople use *direct sales* techniques to sell products door-to-door or through parties in people's homes.

Steps in selling

Although there are many kinds of salespeople, most personal selling efforts follow the same basic steps in making a sale. These steps are (1) prospecting, (2) preparation, (3) presentation, (4) persuasion, and (5) postsale services. In many cases, these sales steps overlap.

Prospecting is the process of identifying possible customers, who are called *prospects.* In prospecting, salespeople look for individuals who meet certain requirements. In particular, prospects should have the means to buy a product, the authority to buy it, and the desire to buy it.

People with the means to buy a product may have the cash to buy it. Or they may have a good credit rating, which would enable them to buy the product on credit or to borrow money for the purchase.

People with the authority to buy a product are those who are legally permitted to do so. For example, people under a certain age are not legally allowed to buy alcoholic beverages. Only adults have the authority to make such a purchase.

Good prospects also must have the desire to buy a product. No selling effort can make people buy things they do not want. An individual who has just purchased an automobile, for example, probably is not a good prospect for another one. An essential element in prospecting is the identification of the customer's needs and desires. A salesperson seeks to understand the specific characteristics of the customer, as well as the problems the customer wants solved and the needs the customer wants satisfied.

Salespeople use different methods of prospecting, depending on the type of selling involved. In a retail store, for instance, salespeople do not seek out potential customers. Generally, prospects come to them. On the other hand, sales agents who work for manufactur-

ers, wholesalers, or service providers generally need to search for possible buyers. These agents may consult telephone directories, the Internet, lists of past customers, and other sources to find businesses that might want their products.

Real estate and insurance agents also seek out prospects. However, they use different methods because most people buy real estate and insurance only once every several years. As a result, these agents often look for prospects by reading wedding and graduation announcements in newspapers. Newlyweds, college graduates, and new arrivals in a community are good prospects for insurance policies or new homes. Lists of newly issued building permits and of recent house purchases can also serve as sources of prospects.

Salespeople also learn about prospects from other people. They often ask buyers for names of other people who might be interested in or need the product.

Preparation. Salespeople devote much time and effort to preparing to meet with a prospect. They use several techniques to learn about prospects and their needs. Previous sales records may indicate whether a prospect has bought certain products in the past. By studying such records, salespeople may be able to learn whether the customer was satisfied with the purchases.

Salespeople can also learn about prospects by simply observing them. Observation often permits a salesperson to concentrate on a product that a customer is likely to accept. An automobile dealer, for instance, may see that a person's current car is a fuel-saving compact. After such an observation, the salesperson could assume the customer would want to replace his or her old car with a similar new one. As a result, the salesperson may concentrate on showing the prospective buyer fuel-efficient cars instead of models that use a lot of gasoline.

In preparing to present a product to a prospect, salespeople must also learn about the product itself. In this way, they can emphasize the features that would be most appealing to prospective buyers and that would benefit them most. By learning about the product, the salesperson acquires the information necessary to answer any questions that the customer might have. Salespeople also study competitors' products so they can stress the ways in which their product differs from, and is superior to, those of their competitors.

Before meeting with prospects, most salespeople rehearse their presentations. They may study videotapes or tape recordings of their presentation to see if they appear nervous, wordy, or unsure of themselves. Or they may practice in front of a mirror to ensure that they use appropriate gestures and facial expressions. They also may make the presentation to a friend, another salesperson, or to their sales manager.

Presentation. A sales presentation generally follows a three-step outline: (1) recognition of the prospect's needs, (2) demonstration that the product offered will satisfy those needs, and (3) asking for the purchase. But a presentation must be more than an outline. It must be interesting and lively. It also must emphasize the most appealing features of the product and show how it will benefit the prospect.

Salespeople use a variety of techniques in presenting a product. They may show videocassette recordings, computer presentations, slides, or photographs of people using the product. Or they may produce written statements received from customers who were satisfied with the product and recommend that others try it. Such documents are called *testimonials*. Many salespeople also have catalogs that provide pictures of the products and information about them.

In some cases, the salesperson can demonstrate the product itself. To show how a compact disc player works, for example, a salesperson can play a CD on it. Demonstrations can also serve to prove the salesperson's claims about a product. For instance, a piece of cookware that is said to be unbreakable can be dropped on the floor to show that it does not break. If the product is too big or too heavy to be carried, the salesperson may use a model of it in the presentation. Samples are useful in selling such goods as foods and textiles.

Persuasion. Many prospects do not immediately agree to buy a product. Instead, they offer some objection to doing so. Through experience, a salesperson learns to recognize the type of objection being offered. In many cases, the objection is only a way of delaying the decision to buy. The prospect may be afraid that the

Ellis Herwig from Marilyn Gartman

At a training session, salespeople learn how to present their product in a way that is most appealing to potential buyers. Salespeople undergo training throughout their career to keep up with developments in their products and the products of their competitors, and to learn more effective selling techniques.

product will not be satisfactory and so hesitate to purchase it. In such cases, the salesperson continues the presentation in the hope of overcoming the prospect's reluctance. The salesperson tries to convince the prospect that such doubts are groundless and that the buyer will, in fact, benefit from the product.

One method of overcoming reluctance is to grant prospects a *trial period* for using the product. Under such an arrangement, the customer can buy the product immediately. But if the buyer is not satisfied with it, he or she can return the product within a certain length of time and receive a full refund.

In some cases, the prospect's objection is actually a request for more information about the product, and the salesperson should try to provide it. For example, a customer at an automobile dealership may have expressed interest in a certain model but object to the colors of the cars displayed in the showroom. Such an objection may actually be a request for more information on what colors are available.

In other cases, the objection to buy the product will be final—that is, the prospect cannot buy the product or has definitely decided not to do so. At this point, the salesperson can only end the sales effort gracefully.

The success of a persuasion effort relies heavily upon the salesperson's knowledge of the product. It also depends on the salesperson's ability to use the proper words to persuade the customer to make the purchase.

Postsale services are tasks a salesperson performs following a sale. It is important for the salesperson to keep the customer satisfied and to encourage future sales. The salesperson documents the sale and gives the buyer a receipt or a copy of the *sales agreement.* A receipt shows that the buyer has become the legal owner of the product. A sales agreement documents the terms and conditions of the sale, as well as any obligations assumed by the seller or the purchaser. If the purchase was made on credit, the salesperson forwards the sale information to the company's accounting department so that the customer can be billed. The information also serves as a record of the purchase so that stocks can be replenished, and it can be filed for future reference.

For certain products, salespeople must make plans for the goods to be delivered to the buyer's home. They may also have to arrange for the buyer to obtain a warranty or operating instructions for the product. Postsale services may also involve offering to maintain or repair products when needed.

Regulation of selling

Most nations have laws and regulations regarding sales practices. These measures are usually aimed at ensuring that both the buyer and seller are treated fairly. For example, there are laws that seek to prevent salespeople from lying to prospects about the nature of the product or the way it performs. Certain laws also prevent companies from failing to deliver a product that has been ordered or from delivering a cheaper version of the product. In the United States, selling is regulated by the Federal Trade Commission (FTC) and other federal agencies and by various state and local agencies.

Certain salespeople are required by law to obtain licenses. Real estate agents in the United States, for example, must pass a written examination on their knowledge of real estate to receive a license. Salespeople who sell products on sidewalks and other public property may be required to have licenses. Strict regulations typically govern the sale of potentially hazardous products, such as guns and chemicals.

Selling may also be supervised by private organizations. *Better business bureaus* and local associations of business people set standards of conduct that protect buyers from unfair or deceptive sales practices. Certain trade associations also oversee selling practices. Most companies also have policies designed to ensure that their salespeople use responsible, fair sales techniques.

History

The rise of sales. Selling has been practiced for thousands of years. The earliest remains of prehistoric peoples indicate that they traded various products. For instance, hunters could trade food for utensils and other goods. Similarly, pot makers could trade pots for food. By trading with each other, both individuals would benefit. In the course of trading, these early bargainers probably used many of the basic principles of selling.

Many of the earliest writings are sales orders and other commercial records, indicating that ancient peoples had complex trade networks. After the development of money in about the 600's B.C., people could sell goods without having to exchange them directly for other goods. As a result, trade expanded and so did selling.

From about the A.D. 400's to the 1100's, however, little trading or selling took place in Western Europe. Most of the people made everything they needed at home. They grew their own food, and they made their own clothing and the tools they needed for their work.

As towns began to grow in the 1100's and 1200's, some townspeople began to specialize in making certain goods. Cobblers made shoes, tailors sewed clothing, and metalsmiths created tableware and jewelry. Some of these tradespeople produced large quantities of goods for merchants to sell across wide areas. Some merchants opened stores. Others traveled far and wide to buy, sell, and trade.

The Industrial Revolution of the 1700's and early 1800's increased the importance of selling. During the Industrial Revolution, machinery replaced much hand labor. Machines produced items more quickly and more cheaply than people could make them by hand. Soon, goods that once only the rich could afford were so inexpensive that common people could buy them. In addition, many new products, such as the sewing machine, the steam engine, and the reaper, were invented. But people did not start buying merely because goods were available. Instead, they had to be convinced that the products were worthwhile and that they would benefit from owning them. Thus, many manufacturers hired salespeople to promote their goods.

Early sales efforts usually involved peddlers traveling to potential customers and demonstrating their products. These early salespeople often took orders for products to be delivered at a later date. The delay in delivery was due to the inability of salespeople to safely carry sufficient quantities of their products.

The peddler's life was strenuous, lonely, and hazardous. Some peddlers walked, many rode horses, and a few of the wealthiest had wagons or carriages. Most

peddlers spent a great deal of time on the road. When the opportunity arose, many of them were happy to settle down as storekeepers.

Modern sales. As nations expanded and economies grew, the salesperson's duties and responsibilities changed. Selling became recognized as a profession that required special training and skills. Salespeople became an important link between the customer and the company, helping to settle any disputes that arose. Since 1900, the types of merchandise sold have become more complex and sophisticated. New markets have expanded over large areas, and selling has become increasingly international in scope.

Current trends in sales. Many methods and techniques of selling have continued to develop in the late 1900's and early 2000's. The increased use of computers has made the Internet a major force in modern sales efforts. Salespeople can use the Internet to find prospective customers and to gather information about them. Companies can use it to handle customer orders and to respond to questions. Many Internet Web sites serve as online catalogs where customers can acquire some information about products before talking or meeting with salespeople.

Another modern trend is the increased emphasis on *relationship-oriented* sales efforts. These efforts seek to develop long-term relationships with customers, rather than focusing on a single transaction. Because of the increased complexity of markets and the focus on relationship-oriented selling, *team sales* efforts have become more common. In many cases, companies assign formal teams of salespeople to maintain relationships with major customers.

Careers

Careers in sales vary greatly. Some salespeople work in retail stores. Other salespeople communicate with customers primarily by telephone. Some salespeople travel from store to store or office to office, repeatedly calling on the same customers. Still others focus on Internet-based sales efforts.

Many sales careers offer people an opportunity to be largely their own boss and a chance to earn more money than is possible in many jobs. Selling also provides salespeople with a way to meet a wide variety of people.

Characteristics needed. The personal characteristics that contribute to selling success include *empathy, drive,* and *efficiency.* Empathy is the ability to listen to other people and understand their point of view. Drive is, basically, the motivation to succeed. Many potential barriers stand in the way of any given sale. Salespeople must have the persistence to overcome those obstacles. Efficiency is the ability to use time wisely. For example, salespeople must make careful plans to reduce their time on the road, their waiting time to see the prospect, and their time out of the office.

Training. Sales training begins before salespeople meet their first prospect. Before attempting a sale themselves, beginning salespeople often accompany an experienced salesperson to see how sales are actually conducted. Training continues throughout a salesperson's career. Salespeople must keep abreast of products, including those from their competitors, and of new sales techniques. To do so, they attend special classes from time to time and read a variety of books and journals.

Michael Ahearne and Joel Le Bon

Related articles. See the *Careers* section in such articles as **Automobile, Clothing, Petroleum,** and **Radio.** See also:
Advertising
Careers (Sales)
Direct Selling Association
Insurance (The insurance industry)
Internet (Business transactions)
Mail-order business
Market research
Marketing
Real estate
Retailing

Engraving (1868) (Granger Collection)

Yankee peddlers of the 1700's and early 1800's traveled from house to house selling such needed goods as rifles, cooking utensils, fabrics, axes and other tools, and ammunition.

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Sales, Saint Francis de. See Francis de Sales, Saint.

Sales tax is a tax on the sale of goods and services. The tax is a percentage of the sale price, and typically ranges from 4 to 7 percent. Retail businesses generally collect the tax from their customers and send the money to the government.

The two main kinds of sales taxes are *general sales taxes* and *excise taxes.* General sales taxes charge a single rate on the sales of consumer goods. Excise taxes apply only to specific products or services. They include taxes on gasoline and tobacco.

Sales taxes raise a great deal of money and are relatively easy to administer at low rates. Governments that use general sales taxes include most state and many local governments in the United States, as well as the federal and many provincial governments in Canada. Many national governments in Europe, Latin America, and elsewhere do not use sales taxes, however. Instead, they raise money through a *value-added tax,* which the government collects from companies at every stage in an item's production.

The main objection to sales taxes is that they fall heavily on low-income groups. People with low incomes spend a large percentage of their wages on consumer goods. Therefore, they may pay more sales tax in relation to their income than wealthy people do.

People disagree about whether sales over the Internet should be subject to sales taxes. Internet sellers argue that it would be too expensive to comply with the different tax rules of their customers' local governments. Other retailers complain that freedom from sales taxes would give Internet sellers an unfair advantage.

Joel Slemrod

See also **Excise; Taxation** (Taxes on transactions); **Value-added tax.**

Salic law, *SAL ihk,* was a set of laws used in Europe during the Middle Ages. The laws were written in Latin and based on Germanic customs. Historians believe that Clovis, a king of the Germanic people known as *Salian Franks,* had the laws written down about A.D. 500.

In the 1300's, the Salic law played an important part in history. The last son of King Philip IV of France died without a direct male heir. Edward III of England, son of a daughter of Philip IV, claimed the kingdom. To keep Edward from gaining the throne, French lawyers argued that the Salic law forbade inheritance of a kingdom by or through a woman. The French recognized Philip VI, son of a brother of Philip IV, as their king. The resulting struggle between France and England became known as the Hundred Years' War (1337-1453).

The Salic law actually said nothing about royal succession. It simply stated that women could not inherit Salic land. As a result of the dispute over the French throne, however, the term *Salic law* came to mean the idea that a woman or her descendants could not inherit royal authority. Emily Zack Tabuteau

Salicylic acid, *sal uh SIHL ihk,* belongs to a group of chemical compounds used as drugs to reduce fever and pain. Acetylsalicylic acid, one of the most widely used drugs, is prepared from salicylic acid. Acetylsalicylic acid is commonly known as aspirin. See **Aspirin.**

Salicylic acid is also used in treating ringworm and eczema, and in making dyes. It is also an effective food preservative. But its use for this purpose is forbidden in the United States and in some other countries because salicylic acid can be poisonous in large amounts. A naturally occurring derivative of salicylic acid called *methyl salicylate* is also useful. It smells like wintergreen and is used as a food flavoring and in ointments designed to relieve muscular pain.

Salicylic acid is a white powder and has the chemical formula $C_6H_4(OH)(COOH)$. It was first prepared in 1838 from *salicin,* a compound found in the bark of willow trees. Dorothy M. Feigl

Salinas de Gortari, *suh LEE nuhs day gawr TAHR ee,* **Carlos** (1948-), was president of Mexico from 1988 to 1994. Salinas belongs to the Institutional Revolutionary Party. He succeeded Miguel de la Madrid Hurtado as president. A specialist in economics, Salinas served as secretary of planning and budget in de la Madrid's Cabinet from 1982 to 1987.

As president, Salinas took steps to modernize Mexico's economy, including the sale of hundreds of government-owned companies. He also promoted the establishment of the North American Free Trade Agreement (NAFTA), an economic union among Mexico, the United States, and Canada.

Wesley Bocxe, JB Pictures

Carlos Salinas de Gortari

Salinas was born on April 3, 1948, in Mexico City. He earned a bachelor's degree at the National Autonomous University of Mexico in 1969. He later earned two master's degrees and a doctor's degree from Harvard University. Before becoming a Cabinet member, he worked for several federal financial agencies. Roderic A. Camp

Salinger, *SAL uhn juhr,* **J. D.** (1919-), an American author, became famous for his novel *The Catcher in the Rye* (1951). Its hero and narrator is a prep school student named Holden Caulfield, who is expelled for failing grades. Adrift in New York City, Holden learns to face both the phoniness he finds in the adult world and his own weaknesses. In *Catcher,* and in much of his later fiction, Salinger humorously and convincingly captured the speech, gestures, and feelings of the young.

Salinger's *Nine Stories* (1953) introduces the Glass family, central figures of the author's later works. One story in this book focuses on Seymour Glass, an eccentric genius whose suicide haunts the family in other fiction. In *Franny and Zooey* (1961), Franny Glass suffers a spiritual breakdown. Her brother Zooey blames his older brothers for Franny's condition, but he draws on their wisdom to help her. Salinger also focuses on Seymour in three stories first published in *The New Yorker* magazine. These stories are "Raise High the Roof Beam, Carpenters" (1955), "Seymour: An Introduction" (1959), and "Hapworth 16, 1924" (1965).

Jerome David Salinger was born in New York City. Since the 1950's, he has isolated himself in rural New Hampshire. He still writes fiction but feels that publishing it would invade his privacy. Barbara M. Perkins

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Salisbury, Zimbabwe. See **Harare.**

Salisbury, *SAWLZ BEHR ee,* lies about 80 miles (130 kilometers) southwest of London, in southern England (see **England** [political map]). It is the chief town in the district of Salisbury, which has a population of about

Eberhard Streichan, Shostal

Salisbury, England, is famous for its cathedral.

102,500. Salisbury is also called New Sarum (pronounced *SAR uhm*). The town has several service and high-technology industries. It is also a popular tourist attraction. The town is famous for its cathedral, the top of whose spire is 404 feet (123 meters) from the ground. The cathedral was built as part of a new town to replace the town of Old Sarum in the 1200's. All that remains of Old Sarum is a large mound with earthen *ramparts* (defensive banks). Stonehenge, the largest prehistoric structure in western Europe, stands near Salisbury (see **Stonehenge**). D. A. Pinder

Salisbury, *SAWLZ BEHR ee,* **Marquess of** (1830-1903), was a distinguished British statesman who was prime minister three times. He entered the Cabinet in 1866 and again in 1874 as secretary of state for India under Prime Minister Benjamin Disraeli. In 1878, he became secretary of state for foreign affairs. When Disraeli died in 1881, Salisbury became leader of the Conservative Party in the House of Lords. He was prime minister from June 24, 1885, to Feb. 6, 1886; from Aug. 3, 1886, to Aug. 8, 1892; and from July 2, 1895, to July 12, 1902. During most of this period, Salisbury also served as his own secretary of state for foreign affairs.

Salisbury was born Robert Arthur Talbot Gascoyne-Cecil in Hatfield in Hertfordshire, England. Salisbury was educated at Oxford University. He was elected to the House of Commons in 1853, and remained a member until the death of his father in 1868 gave him a seat in the House of Lords. Keith Robbins

Salish Indians, *SAY lihsh,* are certain related groups of North American Indians. They speak forms of the Salish language and were once the main inhabitants in parts of present-day Idaho, Montana, Oregon, and Washington in the United States and British Columbia in Canada. The Salish consist of two major groups of tribes—the Coast Salish and the Interior Salish.

The Coast Salish lived along the Northwest Coast. They included such tribes as the Quinault and Nisqually. Their traditional way of life centered around fishing, particularly for salmon. They also hunted small game and gathered roots and berries. During the summer, they lived in small huts near choice fishing grounds. In the winter, family groups shared large, wood buildings known as *long houses.* Salish chiefs often hosted feasts called *potlatches* for tribal members.

There were at least 25,000 Coast Salish when Europeans first came to their lands during the late 1700's. Nearly all the Coast Salish in the United States moved to reservations in their traditional territories during the 1850's. Canadian bands were moved to small reserves by 1916. Today, about 8,000 Coast Salish live in the United States, and about 4,500 live in Canada. Many of them continue to fish, using modern technology and equipment. Others work in industry and the professions in Tacoma and Seattle in Washington, and in Vancouver and Victoria in British Columbia.

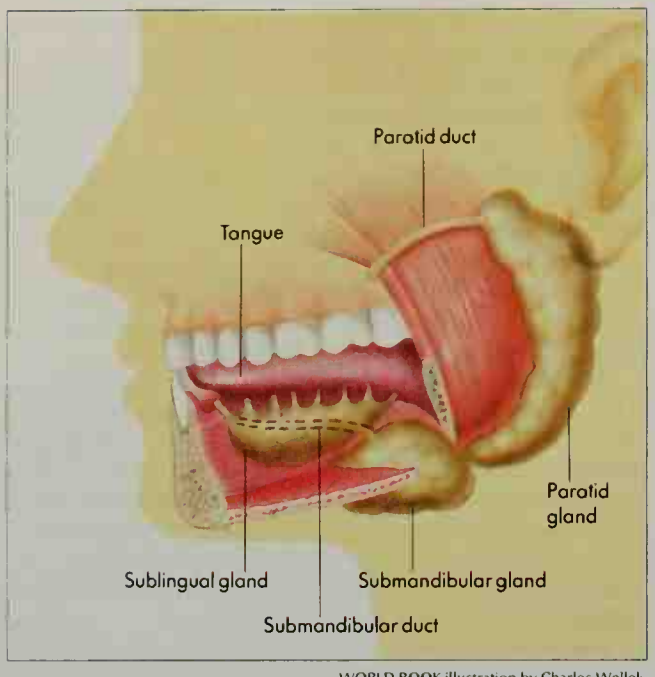
The Interior Salish lived on the plateau east of the Cascade Mountains in the United States and the Coast Range in Canada. Salish who lived in the western part of this region had a culture similar to that of the Coast Salish. During the summer, these Interior Salish lived in mat-covered lodges and spent much of their time fishing. During the winter, they lived in earthen lodges and hunted deer, elk, bear, and other game.

In the eastern part of the interior, such Salish tribes as the Flathead adopted many practices of neighboring Plains Indians. They mainly hunted buffalo and other large game by horseback and lived in tepees made of animal skins when traveling across the plains. These Interior Salish also practiced such Plains Indian ceremonies as the sun dance (see **Sun dance**).

By about 1800, there were approximately 35,000 Interior Salish in North America. At that time, most of them worked as fur trappers and traders. The Interior Salish in the United States were placed on reservations between the 1850's and the 1880's. All Canadian bands were moved to reserves by the early 1900's. Today, about 8,000 Interior Salish reside in the United States, and 12,000 live in Canada. Most work in their traditional communities as cattle ranchers, farmers, and loggers. Many have moved to cities. Robert S. Grumet

Saliva, a sticky fluid produced in the mouth, is important to the digestion of food. It has a colorless and watery appearance. It contains some mucus and produces an *alkaline* (acid-neutralizing) chemical action. Saliva contains an enzyme called *ptyalin.* Ptyalin changes starches into such simpler substances as *maltose.*

Saliva moistens and softens all food that is taken into



WORLD BOOK illustration by Charles Wellek

Saliva is produced chiefly by three pairs of glands: the parotid, the sublingual, and the submandibular. Saliva moistens and softens the food, thus helping in chewing and swallowing. It also contains an enzyme that begins the digestion of starches.

the mouth. It helps in the chewing and swallowing of food. It also keeps the mouth moist, which is important to comfort. Its most important action is on starchy foods. Saliva breaks down all starches into maltose, the first step in digestion.

Three pairs of glands in the mouth and cheeks, known as *salivary glands,* produce saliva. One pair of glands, the *parotid,* is located in front of the ears. Another pair, the *submandibular,* is located under the lower jaw. The third pair of glands is located under the tongue and is known as the *sublingual.* There are several other small glands in the mucous membrane of the mouth that aid in producing saliva. Kermit L. Carraway

See also Mastication.

Salivary glands. See Saliva.

Salk, *sawlk* or *sawk,* **Jonas Edward** (1914-1995), an American research scientist, worked in the field of preventive medicine. He gained his greatest recognition for developing a vaccine that became the first effective weapon in preventing poliomyelitis (see Poliomyelitis). Albert B. Sabin later developed an effective oral polio vaccine (see Sabin, Albert B.).

In addition to his work on poliomyelitis, Salk also made significant contributions to the understanding of influenza, a severe infectious disease. Both poliomyelitis and influenza are caused by viruses, the microorganisms which are the smallest germs (see Virus).

Vast amounts of material about immunity had accumulated since "the golden age of bacteriology" in the last half of the 1800's. Salk had to distill this information and apply the findings to his polio vaccine. He found it necessary to weaken the virus with formalin without knocking out its ability to stimulate the body to produce protective antibodies. Since each type of microorganism has its own antibodies, Salk's vaccine contained all three polio virus types recognized at the time.

The Salk vaccine. In 1953, Salk announced the development of a trial vaccine. The viruses the vaccine contained had been killed with a formaldehyde solution. Among the first to receive the vaccine were Salk, his wife, and their three sons. The vaccine was found safe, and there was evidence that it was effective.

It was further tested during a mass trial on 1,830,000 schoolchildren in 1954. This trial was sponsored by the National Foundation for Infantile Paralysis (now the March of Dimes Birth Defects Foundation), which had given $1,700,000 to Salk and his researchers for their project. The vaccine was pronounced safe and effective in April 1955. Salk received many honors, including a citation from President Dwight D. Eisenhower and a congressional gold medal for "great achievement in the field of medicine." He refused all cash awards and returned to his laboratory to improve the vaccine.

His life. Salk was born in New York City, the oldest of a garment industry worker's three sons. He helped pay for his education by working after school and earning scholarships. He graduated from the New York University School of Medicine in 1939. There he did research with viruses in the laboratory of Thomas Francis, Jr.

In 1942, Salk went to the University of Michigan on a research fellowship and advanced to the position of assistant professor of *epidemiology* (the study of the causes and control of epidemics). Francis had become head of the department of epidemiology at Michigan's school of public health. Salk worked with Francis to develop influenza vaccines. Later, Francis directed the evaluation of the mass tests of the Salk antipolio vaccine.

Salk taught at the University of Pittsburgh from 1947 to 1964. In 1963, the Salk Institute for Biological Studies was established in La Jolla, California. Salk served as director of the institute. Audrey B. Davis

Additional resources

Bredeson, Carmen. *Jonas Salk.* Enslow, 1993. Younger readers.
Curson, Marjorie. *Jonas Salk.* Silver Burdett, 1990.

March of Dimes Birth Defects Foundation

Jonas E. Salk administers an injection during the mass testing of his polio vaccine in 1954. Salk's vaccine was the first to successfully prevent this feared disease.

Hargrove, Jim. *The Story of Jonas Salk and the Discovery of the Polio Vaccine.* Children's Pr., 1990. Younger readers.
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Salmon, *SAM uhn,* is one of the most important food and sport fishes. Every year, people throughout the world eat millions of cans of pink or red salmon. Fishing enthusiasts also catch millions of salmon yearly.

Most of the salmon sold comes from five *species* (kinds) that live in the coastal waters of the North Pacific Ocean. Two other Pacific species live only in northern Asian waters. One species, called the Atlantic salmon, lives in the North Atlantic Ocean. This fish is not closely related to the salmon in the Pacific Ocean.

Salmon are born in a freshwater stream or lake, and most spend part of their life in the salt water of the ocean. They then return to the freshwater area of their birth to *spawn* (reproduce). Most Pacific salmon spawn only once and die soon afterward. Atlantic salmon may swim back to the ocean after spawning and return to fresh water to spawn as many as three more times. Some salmon are *landlocked* (cut off from the ocean) in lakes and streams. Adult salmon swim upstream at spawning time. The fish are famous for their fighting spirit. They battle currents and leap across rapids and up waterfalls as high as 10 feet (3 meters). When hooked, they struggle furiously to escape.

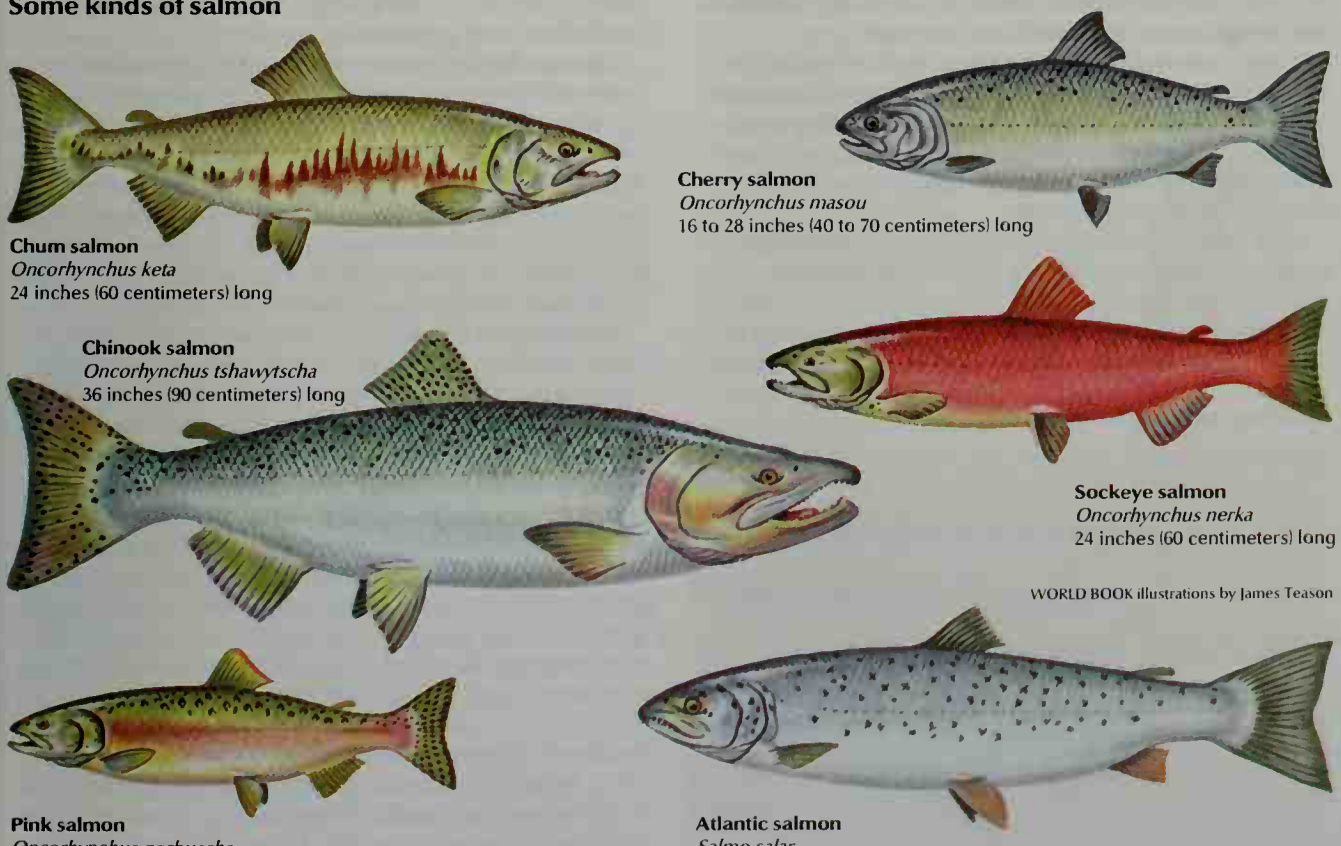
The life of a salmon. Most salmon spawn during the summer or autumn after swimming upstream as far as 2,000 miles (3,200 kilometers) from the ocean. The journey may take several months. Female salmon lay their eggs in the gravelly bed of a shallow, rippling stream or at beaches along lakeshores. A male salmon stands guard as the female turns on her side and digs a saucer-shaped nest in the gravel by swishing her tail back and forth. The female lays her eggs in the nest, and the male fertilizes them with sperm. The female then swims forward a short distance, digs another nest, and lays more eggs. The spawning process may occur several times. The gravel dug from each nest normally washes back and covers the previously laid eggs. During spawning, the female lays a total of 2,000 to 17,000 eggs.

The eggs hatch after two to four months, and the baby salmon lie hidden in the gravel for up to several more months. They feed on a *yolk sac* (a baglike structure containing food materials) attached to their stomach. Some kinds of salmon leave fresh water for the ocean immediately after they come out of the gravel. Other species may spend up to three years in fresh water. They eat insects and water organisms called *plankton.*

Only a small percentage of the salmon reach the ocean from fresh water. Fish and birds eat some salmon, and polluted water kills others. Many of the salmon die in huge artificially created reservoirs.

Salmon that reach the ocean live there from six months to seven years. During this period, they feed mainly on shrimp, squid, and small fishes. Some salmon travel thousands of miles or kilometers from the river where they were born. But most salmon return for spawning to the same stream or lake in which they hatched. Many scientists think salmon navigate in the sea by somehow sensing the magnetic field of the earth, the currents of the ocean, and the position of the sun. After reaching the coast, the salmon apparently remember the odor of their "home" stream and follow this scent.

Some kinds of salmon



Salmon stop eating after reaching fresh water to spawn. They live off fat stored in their body. As the fish travel upstream, their shape and color change. For example, all male salmon develop a hooked snout. Male pink salmon grow a large hump on their back. Chum salmon of both sexes develop purple streaks on their sides, and sockeye salmon turn bright red.

Many salmon do not complete the spawning journey. Commercial fishing crews and sports enthusiasts catch large numbers of the fish. Some salmon are killed by pollutants dumped into the rivers by industries. Artificial sloping waterfalls called *fish ladders* have been built to help salmon travel over dams. But some salmon become so weakened climbing the ladders that they die.

Kinds of salmon. There are eight species of salmon: (1) amago, (2) Atlantic, (3) cherry, (4) chinook, (5) chum, (6) coho, (7) pink, and (8) sockeye. All except Atlantic salmon live in the Pacific Ocean.

Amago salmon, the smallest species, grow only about 5 to 9 inches (12 to 24 centimeters) long. They live in southern Japan.

Atlantic salmon are not nearly so plentiful as Pacific salmon and have much less commercial importance. Most Atlantic salmon measure about 2 $\frac{1}{2}$ feet (75 centimeters) long and weigh about 10 pounds (4.5 kilograms).

Cherry salmon, or *masu salmon,* live in coastal waters and rivers of eastern Asia. They vary in length from about 16 to 28 inches (40 to 70 centimeters) and weigh from 5 to 23 pounds (2.3 to 10 kilograms).

Chinook salmon, the largest species, are also known as *blackmouth, king, quinnat, spring, tule,* or *tyee salmon.* Most chinooks are about 3 feet (90 centimeters) long and weigh about 22 pounds (10 kilograms).

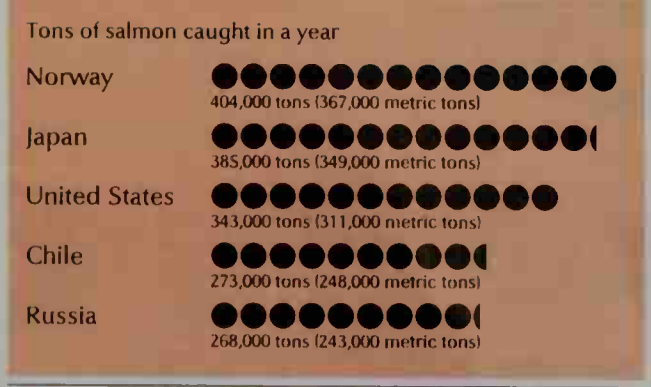
Chum salmon are also called *calico, dog,* or *keta salmon.* They grow about 2 feet (60 centimeters) long and weigh about 10 pounds (4.5 kilograms).

Coho salmon are also known as *medium red, silver,* or *silverside salmon.* They are about 2 feet (60 centimeters) long and weigh about 10 pounds (4.5 kilograms). Scientists have introduced cohos into the Great Lakes. The salmon provide fishing and help control the number of alewives. See Alewife.

Pink salmon, or *humpback salmon,* grow about 20 inches (50 centimeters) long. They weigh about 5 pounds (2.3 kilograms).

Sockeye salmon, also known as *blueback* or *red salmon,* are the most valuable food salmon. A sockeye measures about 2 feet (60 centimeters) long and weighs about 6 pounds (2.7 kilograms). *Kokanee salmon* are a landlocked variety of sockeye salmon.

Leading salmon-fishing countries



Figures are for 1997.
Source: Food and Agriculture Organization of the United Nations.

© Johnny Johnson, DRK

Salmon leap up a waterfall as they journey upstream to spawn, *shown here.* They may swim upstream as far as 2,000 miles (3,200 kilometers). Many die or are caught during the journey.

Salmon fishing. After salmon enter fresh water, their flesh loses flavor and color. Therefore, commercial fishing crews catch salmon as the fish leave the ocean to journey upstream. Most salmon are caught in nets. Some salmon is sold fresh, frozen, or smoked, but most is canned. Salmon fishing and processing rank as major industries in Alaska, Oregon, and Washington, and in the Canadian province of British Columbia. Fish farms in these areas also produce much Pacific salmon.

Sport fishing for salmon is popular in the United States and Canada. Coastal waters, lakes, and rivers in many parts of the world have been stocked with salmon. But transplanted salmon thrive only in a few places, such as the Great Lakes and New Zealand.

Salmon conservation is based on the theory that a certain number of fish, called the *escapement,* should be allowed to spawn in each stream. Fishing is regulated to ensure the proper escapement. Conservation programs must also overcome such obstacles as dams, irrigation ditches, and pollution. In many areas, including northwestern North America, overfishing and other factors have sharply cut the salmon populations.

The most important advance in conservation has been the development of improved hatcheries. These hatcheries, helped by increasing knowledge of fish nutrition and diseases, can produce thousands of healthy salmon to restock rivers and streams. Other conservation efforts have resulted in new designs for dams and fish ladders.

Artificial spawning channels, with controlled water flow and temperature, have also been developed.

David W. Greenfield

Scientific classification. Salmon are in the trout family, Salmonidae. Pacific salmon belong to the genus *Oncorhynchus*. Atlantic salmon are *Salmo salar*.

See also Fish (The bodies of fish; pictures: Fish hatcheries, Fish of temperate fresh waters).

Salmonellosis, *SAL muh nuh LOH sihs,* is a common type of food poisoning. It is often called *salmonella* because it results from infection by certain types of *Salmonella* bacteria. People get salmonellosis from food or water contaminated with these bacteria. Poultry, milk, eggs, and products made from eggs are the foods that most often carry the bacteria. There are also other types of *Salmonella* bacteria that cause a number of other infectious diseases. For example, the *Salmonella typhi* bacterium causes typhoid fever (see Typhoid fever).

Salmonellosis is usually confined to the intestines. It may spread throughout the body in chronically ill people and in people who have a deficient immune system or sickle cell anemia. The bacteria cause symptoms of the disease by releasing a poison called a *toxin*. The toxin stimulates the secretion of fluids in the small intestine, producing diarrhea. Other symptoms of salmonellosis include nausea, abdominal pain, and fever.

Most adults who get salmonellosis recover in two to five days. The disease may last longer and be more severe in infants and elderly people. Severe cases are sometimes treated with antibiotics. People can best prevent salmonellosis by refrigerating prepared foods, by thoroughly cooking poultry and other foods that may carry the bacteria, and by carefully washing their hands before meals. James L. Franklin

See also Food poisoning.

Salome, *suh LOH mee,* was the daughter of Herodias and the stepdaughter of Herod Antipas, governor of Galilee and Peraea. She is said to have caused the beheading of Saint John the Baptist. The story is told in Matthew 14: 6-12 and in Mark 6: 22-28. However, her name is not given in the Bible, where she is only called the daughter of Herodias. According to Matthew's story, Salome danced at a birthday party for Herod. He was so pleased that he offered to grant Salome any wish. At her mother's suggestion, Salome requested the head of John the Baptist. Herod ordered John beheaded and sent the head to Salome on a platter.

Another Salome appears in the Bible as one of the holy women present at the Crucifixion of Jesus and later at the empty tomb of Jesus (Mark 15: 41 and 16: 1). This Salome was possibly the wife of Zebede and the mother of the apostles James and John. J. H. Charlesworth

See also Herod (Antipas); Opera (The 1900's; The opera repertoire; picture: *Salome*); Strauss, Richard.

Salomon, *SAL uh muhn,* Haym, *hym* (1740-1785), was an American banker and patriot. During the Revolutionary War in America (1775-1783), Salomon operated a successful brokerage firm that made numerous loans to the American army and government.

Salomon was born in Lissa, Poland. He went to New York in 1772 after taking part in a struggle for Polish independence. Salomon soon became involved in the movement for American independence. The British government arrested him as a spy in 1776, and again in 1778. After the second arrest, Salomon was sentenced to death. However, he escaped by bribing his jailer. Salomon later opened his brokerage firm in Philadelphia.

William Morgan Fowler, Jr.

Salon, *suh LAHN,* refers to a type of room and to certain activities that take place in the room. The word *salon* comes from the Old French word *sale,* which means *great hall*. Originally, a salon was a large reception room in a palace. It provided an impressive setting for entertaining guests or meeting the public. Some salons were two stories high, with an arched ceiling and several windows. Many salons had elaborate sculptured and painted decorations on the walls.

During the 1600's and 1700's, artists in the French Royal Academy held exhibitions of their work in the Salon Carré in the Louvre Palace in Paris. These exhibitions became known as *salons*. The term still means an annual exhibition of the work of living artists. Because the Louvre salon was the only public art exhibition in Paris, it established an official, approved style of art. Many artists protested the salon's control over public taste. In 1863, the Salon des Refusés was established by artists whose work had been refused by the official salon. Many founders of modern art exhibited there.

The term salon can also mean a gathering of fashionable people. During the 1700's, wealthy Parisians built town houses with elegantly decorated salons. The hostess usually invited writers, philosophers, politicians, and aristocrats. These French salons became famous for their brilliant conversation. Marilyn Stokstad

See also Furniture (French styles; picture: The French neoclassical style).

Salonika. See Thessaloniki.

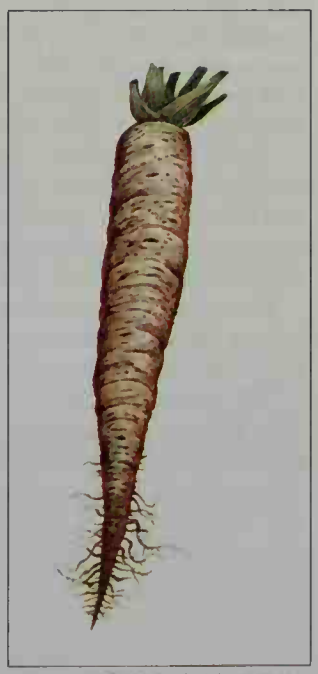
Salpiglossis. See Painted-tongue.

Salsify, *SAL suh fy,* is a garden vegetable. It is also called oyster plant because its root has an oysterlike flavor. The plant is native to the Mediterranean area but also grows in the United States. The tapering roots are used in Europe and America as a table vegetable. A common method of preparation consists in cutting the roots into small pieces, boiling until tender, and creaming. They are also good boiled, then dipped in cracker crumbs and fried. They give an agreeable flavor to soups. Farmers cultivate salsify in the same way as the parsnip. The roots are easily kept over winter if stored in cool, moist earth.

W. E. Splittstoesser

Scientific classification. Salsify is in the composite family, Asteraceae or Compositae. Its scientific name is *Tragopogon porrifolius*.

See also Parsnip.



WORLD BOOK illustration by John D. Dawson

The salsify root acquires an oyster flavor after a heavy frost, and so the vegetable is often called *oyster plant*.

Cameramann International, Ltd.

WORLD BOOK photo by Dan Miller

Salt, one of the most important minerals, has a wide range of uses. Most salt is consumed by the chemical industry. The huge mound of salt, *left,* will be transported to a plant where it will be used to produce chemicals or chemical products. Salt is also a valuable food seasoning, *right.*

Salt is a clear, brittle mineral that has been used to flavor and preserve food since ancient times. Today, salt is also used in the manufacture of a large number of chemicals and chemical products.

Salt consists of the elements sodium and chlorine. Its chemical name is *sodium chloride* and its formula is NaCl. Its mineral name is *halite.* Salt usually forms clear crystals that are almost perfect cubes. However, impurities in the salt may make it appear to be white, gray, yellow, or red. Table salt also appears to be white, but it actually consists of clear cubes.

The source of all salt—even deposits that are located underground—is *brine* (salty water) from seas, salt lakes, and similar bodies of water. Salt deposits that now lie underground were formed by the evaporation of seawater millions of years ago.

The United States and China rank as the leading countries in salt production. Other important salt-producing countries include Germany, Canada, India, and Mexico.

Salt is necessary to good health. Human blood contains salt, and body cells must have salt to function properly. However, some studies have suggested that too much salt or other sodium compounds in a person's diet can lead to high blood pressure. For this reason, many people attempt to reduce the amount of salt they eat. Some people use salt substitutes that do not contain sodium.

Uses of salt

In the chemical industry. The chemical industry, which consumes the largest amounts of salt, uses it mainly to produce other chemicals. Salt can be broken down and used to make a variety of sodium and chlorine products. About 20 per cent of the salt consumed in the United States is used to make a sodium compound called soda or soda ash. Soda is used primarily in the manufacture of glass and soap.

Chlorine products account for about 45 per cent of the salt consumed in the United States each year. Chlorine compounds are used in the manufacture of paper, plastics, pesticides, cleaning fluids, and antifreeze and other automotive fluids.

As a deicer. When salt is mixed with ice, the melting point of ice is lowered. As a result, salt is often spread on roads and highways to melt snow and ice. About 20 per cent of the salt consumed in the United States is used for this purpose.

In the food industry. Only about 5 per cent of the salt that is consumed in the United States today is used as a seasoning for food. This figure includes both use of salt in the home and industrial use by food-processing plants.

Other uses. Salt is also used in a wide range of other products and processes. These products and processes include ceramic glazes, livestock feed, medicines, oil refining, refrigeration, sewage treatment, textile dyes, and water softening.

Where salt comes from

Salt from the sea. Seawater is salty because rain water dissolves minerals containing sodium and chlorine in rocks and soil and rivers carry these minerals to the sea. Evaporating seawater is the oldest method of obtaining salt. Salt that comes from evaporated seawater is often called *solar salt.*

Seawater consists of about 2.5 per cent salt and about

Artstreet

Trucks spread salt on roads and highways during winter to melt snow and ice. About 20 percent of the salt consumed in the United States is used for such deicing.

Isaac Geib, Grant Heilman

A salt block attracts cattle in a pasture. Salt is an essential food for cattle and other livestock. By licking salt blocks, these animals get much of the salt their diet requires.

1 percent other minerals, mostly compounds of calcium, potassium, and magnesium. In a commercial solar salt operation, salt is obtained from seawater by moving the water through a series of *evaporating ponds*. The various minerals in seawater *precipitate* (separate from the water) at different rates. Most of the other minerals precipitate before salt does, and they are thus left behind as the seawater is moved from one pond to another. Most salt that is produced by this evaporation technique is 95 to 98 percent pure sodium chloride.

Solar saltworks require a hot, dry climate to hasten evaporation. Most solar salt is produced in China, France, India, Italy, Japan, and Spain. The only solar saltworks in the United States are located near the Great Salt Lake in Utah and near San Francisco.

Salt from the ground. Salt that occurs in hard, massive layers beneath the ground is called *rock salt*. These deposits were formed by the evaporation of large parts of oceans millions of years ago. They occur along with deposits of such minerals as calcium carbonate and potash, which are also found in seawater.

Underground salt deposits are found on every conti-

Leading salt-producing countries

Tons of salt produced in a year

United States	45,415,000 tons (41,200,000 metric tons)
China	33,984,000 tons (30,830,000 metric tons)
Germany	17,306,000 tons (15,700,000 metric tons)
Canada	14,683,000 tons (13,320,000 metric tons)
India	10,472,000 tons (9,500,000 metric tons)
Australia	9,787,000 tons (8,879,000 metric tons)
Mexico	9,273,000 tons (8,412,000 metric tons)
France	7,716,000 tons (7,000,000 metric tons)
United Kingdom	7,275,000 tons (6,600,000 metric tons)
Brazil	7,165,000 tons (6,500,000 metric tons)

Figures are for 1998.
Source: U. S. Geological Survey.

Leading salt-producing states and provinces

Tons of salt produced in a year

Louisiana	16,424,000 tons (14,900,000 metric tons)
Texas	10,384,000 tons (9,420,000 metric tons)
Ontario	9,166,000 tons (8,315,000 metric tons)
New York	4,542,000 tons (4,120,000 metric tons)
Kansas	3,406,000 tons (3,090,000 metric tons)

Figures are for 1998.
Sources: U.S. Geolngical Survey; Natural Resources Canada.

Liane Enkelis, Stock, Boston

A salt-harvesting machine collects salt that comes from seawater. The water is channeled into empty ponds, where it evaporates. The salt, which remains, is then taken to a refinery.

Morton Thiokol, Inc.

A salt mine has cavelike passages. The salt dome above is being mined by the room-and-pillar method. About half the salt is removed, leaving permanent salt pillars for roof support.

Morton Thiokol, Inc.

Vacuum pan evaporation is a method of producing pure, high-quality salt for table use. Brine is pumped through a series of huge tanks called *vacuum pans, left.* The brine is boiled and agitated vigorously in the pans. This process causes small cubes of salt to form. The cubes settle to the bottom of the pans and are collected and dried.

© Charles Falco, Science Source from Photo Researchers

Salt crystals form nearly perfect cubes.

nent. In the United States, these deposits occur in 32 states. The largest underground salt deposits in the United States are the Salina Basin salts, in Michigan, Ohio, New York, Pennsylvania, and West Virginia; the Permian Basin salts, in Kansas, Oklahoma, Texas, and New Mexico; and the Gulf Coast salts, in Alabama, Mississippi, Louisiana, and Texas. Most of the salt mined in Canada comes from underground deposits in southwestern Ontario.

Most of the Gulf Coast salt deposits occur in formations called *salt domes.* Salt is lighter than most other minerals and will flow when it is under great pressure. Salt domes are formed when beds of rock salt flow upward and break through overlying rock.

There are two basic methods for removing salt from the ground—*room-and-pillar mining* and *solution mining.* In room-and-pillar mining, shafts are sunk into the ground, and miners break up the rock salt with drills. The miners remove chunks of salt, creating huge rooms that are separated by pillars of salt. The room-and-pillar method requires that about half of the salt be left behind as pillars. For more information about room-and-pillar mining, which is also used in mining coal, see Coal (The room-and-pillar system).

In solution mining, a well is drilled into the ground, and two pipes are lowered into the hole. The pipes consist of a small central pipe inside a larger pipe. Fresh water is pumped down the central pipe to the salt deposit. The water dissolves some salt to form brine. The brine is then pumped to the surface through the outer pipe. The brine is either shipped as a liquid or evaporated in special devices called *vacuum pans* to form solid salt.

How table salt is made

After salt has been obtained by mining or evaporation, it is sorted for quality and then crushed, ground, and screened into batches according to particle size. High-quality salt that has been ground into fine particles is used as table salt. This fine-grained salt tends to cake at high humidities, so manufacturers add a *free-flowing agent* (substance that prevents caking) to it before packaging. Common free-flowing agents include magnesium carbonate, calcium carbonate, calcium silicate, and calcium phosphate. All of these compounds are colorless, odorless, tasteless, and harmless.

Much of the table salt purchased by consumers is also *iodized*—that is, it has potassium iodide or sodium

iodide added to it. A lack of iodine in a person's diet can result in a condition called *goiter*, in which the thyroid gland becomes enlarged. A small amount of iodine is enough to prevent goiter, and the addition of iodine compounds to table salt enables large numbers of people to get the iodine they need.

History of salt

Salt has been a precious commodity since ancient times. It was often traded ounce for ounce for gold. The early Chinese used coins made of salt for currency. In many areas around the Mediterranean Sea, salt cakes were used as currency. Several ancient cultures also levied taxes on salt.

The main sources of salt in ancient times were dry coastal areas, particularly those surrounding the Mediterranean Sea. The earliest trade routes centered on Spain, Italy, Greece, and Egypt, and many of the first roads and caravan routes were established for the purpose of transporting salt. Cities such as Genoa, Pisa, and Venice developed as centers for the salt trade.

In the 1300's, people near the coast of the North Sea in northern Europe began trading for salt, which they needed to preserve fish for shipping to inland markets. Later, salt was obtained by boiling the brine from salt springs, and many cities and towns grew up near such springs throughout Europe.

Boiling brine to obtain salt required large supplies of wood for fuel, but this problem was partly solved in the 1700's after coal began to be widely used. England became the largest producer of salt in the world at that time, partly because of its abundant supply of coal.

Colonial America received most of its salt from England. After the Revolutionary War in America (1775–1783), saltworks were set up along the Atlantic Coast for boiling seawater. A salt industry also grew up near where the city of Syracuse, New York, now stands, after salt springs were discovered there. The need to transport salt from Syracuse was one of the main reasons for the construction of the Erie Canal, completed in 1825.

Deep-drilling technology was introduced into salt production in the early 1800's. Most early wells were drilled to improve the quality of salt springs that were already being used in salt production and to locate new ones. Production of salt from underground mines began in the mid-1800's. Drilling helped revolutionize knowledge of the earth's layers. This new knowledge led to increased exploration for salt, potash, and petroleum, and salt exploration indirectly gave rise to such industries as the potash industry and the petroleum industry.

Today, the U.S. government is investigating the possibility of storing radioactive wastes in underground salt mines. Salt mines have several characteristics that make them good sites for radioactive wastes. For example, they have remained stable and dry for millions of years, and most salt mines occur in areas where earthquakes are extremely rare. Salt also is capable of absorbing heat from surrounding objects, and it flows to seal up fractures that form in the walls. Walter E. Dean, Jr.

Related articles in *World Book* include:

Fishing industry (How fish are processed and marketed)
Food preservation (Curing)
Great Salt Lake
Ocean (Composition)
Salt, Chemical
Thirst

Additional resources

Adshead, Samuel A. *Salt and Civilization.* St. Martin's, 1992.
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SALT, talks. See Strategic Arms Limitation Talks.

Salt, Chemical, is a compound that results when a base neutralizes an acid. In this reaction, the metal in the base displaces the hydrogen in the acid. For example, ordinary table salt, sodium chloride, is formed when the base sodium hydroxide neutralizes hydrochloric acid. The salt calcium carbonate is formed when the base calcium hydroxide neutralizes carbonic acid. See **Neutralization.**

Salts are among the most important chemical compounds. They are used in making many industrial and agricultural chemicals. For example, sodium chloride is used in making chemicals needed in the manufacture of rayon, soap, and many other products. The salt ammonium nitrate is used in fertilizers to add nitrogen to soil. Some metals, including sodium and potassium, are extracted from salts. Plants and animals need various salts in order to stay healthy. For example, the salts sodium chloride and potassium chloride supply *ions* (electrically charged atoms) needed by nerve cells.

The earth's crust contains many salts. The most abundant salt, sodium chloride, is found in large land deposits and in the ocean. The salt calcium carbonate is found in limestone and in the shells of sea animals. Well-known natural salt deposits include Great Salt Lake in Utah and beds of borax in Nevada.

The salt formed when a base completely neutralizes an acid is called a *normal salt.* Sodium sulfate (Na_2SO_4), also called *Glauber's salt,* is a normal salt. Incomplete neutralization may produce either an acid salt or a basic salt. These salts act like acids or bases as well as like salts. Acid salts contain hydrogen ions, as in sodium bisulfate ($NaHSO_4$). Basic salts contain hydroxyl radicals, as in basic bismuth chloride ($Bi[OH]Cl_2$ or $Bi[OH]_2Cl$).

A salt crystal contains positive and negative ions in a regular, repeating arrangement. This arrangement is called an *ionic lattice.* When the salt crystal dissolves in water, these ions are released and move about freely in the solution. A *simple salt* such as sodium chloride is made up of only two kinds of ions. One ion is positive and the other is negative. When two simple salts form crystals, the resulting substance is called a *double salt.* Alum, a double salt of aluminum sulfate and potassium sulfate, is used to make cement and to harden plaster casts (see **Alum**). Marianna A. Busch

Related articles in *World Book* include:

Carbonate
Chloride
Halogen
Nitrate
Nitrite
Sulfate
Sulfide

Salt dome. See Salt (Salt from the ground); Petroleum (How petroleum was formed; picture: Where petroleum is found).

Salt Lake. See Great Salt Lake.

Salt Lake City (pop. 181,743; met. area 1,333,914) is the capital and largest city of Utah. Snow-capped mountains provide a beautiful natural setting for this center of culture, industry, commerce, and transportation. The city lies in the Salt Lake Valley at the foot of the Wasatch Range of the Rocky Mountains. It is about 15 miles (24 kilometers) southeast of Great Salt Lake. For location, see Utah (political map).

Salt Lake City is the world headquarters of The Church of Jesus Christ of Latter-day Saints, whose members are known as Mormons. Mormons make up about half of the city's population.

Mormon pioneers, led by Brigham Young, founded Salt Lake City in 1847. According to an account from the time, Young said when he saw the scenic land, "This is the right place." Today, the state celebrates the day of Young's arrival, July 24, as Pioneer Day. The Mormons called their settlement Great Salt Lake City. The name became simply Salt Lake City in 1868.

The city occupies 75 square miles (194 square kilometers) and is the county seat of Salt Lake County. Salt Lake City and Ogden form the center of a metropolitan area that covers Davis, Salt Lake, and Weber counties. About two-thirds of Utah's people live in this area.

Temple Square is at the heart of downtown Salt Lake City. In and near the square are a number of buildings of The Church of Jesus Christ of Latter-day Saints. Salt Lake Temple, with its majestic six spires, stands there. Next to it is the Mormon Tabernacle (officially Salt Lake Tabernacle), famous for its choir and its huge organ with 11,000 pipes. Temple Square also includes the Seagull Monument, a tribute to the gulls that ate crop-destroying grasshoppers, known as Mormon crickets, during the summer of 1848. Across the street from the square stands the 21,000-seat Conference Center. Nearby is the 28-story Church Office Building. Also downtown is the Salt Palace, the city's convention and civic center.

The Utah State Capitol overlooks the city from the north. Its *rotunda* (room under its dome) measures 165 feet (50 meters) from floor to ceiling. A monument at This Is the Place Heritage Park in eastern Salt Lake City, near the spot where the Mormons entered the valley, commemorates Utah's explorers, Indians, and pioneers.

About 90 percent of the city's people were born in the United States. People of English, German, and Mexican ancestry form the largest groups in the city.

Economy. The Salt Lake City metropolitan area has about 700 manufacturing plants. Its leading industries make aircraft parts, chemicals, computer software, electronics, food products, and metal products. A number of petroleum refineries are also in the area.

The city owes much of its industrial importance to the rich natural resources in the area. The largest open-pit copper mine in North America operates in nearby Bingham Canyon. Chemical plants take large amounts of chlorides, magnesium, and potash from Great Salt Lake. Many ski resorts and camping areas in the Wasatch Range help make tourism an important industry in Salt Lake City. State and federal government agencies rank among the chief employers in the city. Salt Lake City also ranks as an important banking center.

Passenger trains and rail freight lines serve the city. Airlines use Salt Lake City International Airport. The city has 2 daily newspapers, *The Deseret News* and *The Salt Lake Tribune*; 7 TV stations; and about 30 radio stations.

Education. The Salt Lake City School District consists of 27 elementary schools and 3 high schools. The city has 2 private schools and 7 church-supported schools.

Alan Yorgason, Salt Lake Convention and Visitors Bureau

Salt Lake City, the capital and largest city of Utah, lies at the foot of the snow-covered Wasatch Range. Mormons, led by Brigham Young, settled in the area in 1847.

Salt Lake Community College, the University of Utah, and Westminster College are in the city.

Cultural life and recreation. The city is the home of Ballet West, a dance company; the Pioneer Theatre; the Mormon Tabernacle Choir; the Utah Opera Company; and the Utah Symphony Orchestra. Other cultural attractions include the Hansen Planetarium, the Hogle Zoo, the Salt Lake Art Center, the Utah Museum of Fine Arts, and the Utah Museum of Natural History. The International Peace Gardens feature flowers and displays representing 25 countries. The city is also the home of the Utah Jazz of the National Basketball Association.

Government. Salt Lake City has a mayor-council form of government. The voters elect a mayor and seven council members to four-year terms. Property taxes provide most of Salt Lake City's revenue.

History. Gosiute (also spelled Goshute), Shoshone, and Ute Indians were living in the Salt Lake Valley when Spanish explorers visited the region in 1776. American frontiersman Jim Bridger saw the Great Salt Lake in 1824. American explorer Jedediah Smith traveled the area in the 1820's and called it his home in the wilderness. Mormon pioneers established Great Salt Lake City in 1847. By 1850, the city had about 5,000 settlers, and it served as an important way station on the Oregon and California trails. Congress created the Utah Territory that year, and Mormon leader Brigham Young was appointed the first territorial governor. The city was incorporated in 1851 and officially became the capital of the Utah Territory in 1856.

The discovery of lead and silver in Bingham Canyon in 1863 led to the development of mining in the region. In 1861, telegraph lines met at Salt Lake City, providing the first transcontinental telegraph service. In 1869, at nearby Promontory, workers laid the tracks that completed the nation's first transcontinental railroad system. The rail service boosted the economy of the Salt Lake City area by opening new markets for its farm and mining products. Utah became a state in 1896, with Salt Lake City as the capital.

Copper, lead, and silver mining boomed in Bingham Canyon during the late 1800's and early 1900's. Mining companies built large smelters to refine the rich ores, and Salt Lake City prospered and grew rapidly. Between 1900 and 1930, the population increased from 53,531 to 140,267. Demand for metals in World War II (1939-1945) brought new prosperity to Salt Lake City's mining industry. Industrial expansion continued after the war and helped the city's population reach 189,454 by 1960.

The population of Salt Lake City dropped in the 1960's, chiefly because of a trend toward suburban living. In the 1970's, the development of two major shopping malls and an urban renewal project revitalized the city's downtown. During the next 20 years, Salt Lake City became a center for medical research, technology, and tourism. In the 1990's, the rebuilding of interstate highways and the completion of a light rail system improved the transportation in the area. In 2002, Salt Lake City hosted the Winter Olympic Games. Will Bagley

For the city's monthly weather, see **Utah** (Climate). See also **Mormons; Utah** (pictures); **Young, Brigham.**

Salt River is a stream in east-central Arizona. It rises in the White Mountains and flows southwest for about 200 miles (320 kilometers). It empties into the Gila River southwest of Phoenix (see Arizona [physical map]). The Salt River Valley is irrigated by four dams, which form a series of artificial lakes extending 60 miles (97 kilometers) along the Salt River. The river is used for irrigation, recreation, and power generation. Lay James Gibson

Saltbush. See Australia (Native plants).

Salter, Susanna Madora (1860-1961), was the first woman mayor in the United States. She was elected mayor of Argonia, Kansas, in 1887 and served for one year. People who opposed prohibition put her name on the ballot as a joke. She was a Woman's Christian Temperance Union officer who favored prohibition. Salter was born March 2, 1860, near Lamira, Ohio. Edward A. Lukes-Lukaszewski

Susanna Salter Home, Museum

Susanna Salter

Salto, *SAHL toh* (pop. 80,787), is the second largest city in Uruguay. Only Montevideo has more people. Salto lies in northwestern Uruguay (see **Uruguay** [map]). The city is a trading center for the farmers and ranchers of northern Uruguay. Salto is sometimes called the *City of Oranges* because of its large orange and tangerine groves. Richard W. Wilkie

Salton Sea, *SAWL tuhn,* is a shallow, saline lake in southeastern California. It is about 30 miles (48 kilometers) long and from 8 to 10 miles (13 to 16 kilometers) wide. Its surface is about 232 feet (71 meters) below sea level. The lake lies chiefly in Imperial County in a valley cut off from the Gulf of Lower California by sediment deposited by the Colorado River. Until 1905, the valley area was a salt-covered depression. Between 1905 and 1907, the Colorado broke through irrigation head gates and flowed into the Salton Basin to form the Salton Sea. The lake covered about 450 square miles (1,165 square kilometers). Evaporation reduced the area and depth of the lake by the 1920's. Since that time, the runoff of irrigation waters from the adjoining Coachella and Imperial valleys has slowly increased the lake area. Roger Barnett

Saltpeter, also called *niter,* is a mineral known to chemists as *potassium nitrate* (KNO_3). It occurs in limestone caves. Industry uses saltpeter to prepare matches, gunpowder, explosives, and fertilizers. Chemists use it as a reagent in analytical chemistry. It is also used as an oxidizer in liquid rocket fuel propellants.

Saltpeter occurs as colorless or white crystals or crystalline powder. It dissolves in water and melts at about 337 °C (639 °F). Saltpeter is manufactured by reacting potassium chloride with sodium nitrate or nitric acid.

The name *saltpeter* also refers to other minerals. The most important is *Chile saltpeter,* composed of sodium nitrate ($NaNO_3$). It is used to make fertilizer, nitric acid, and potassium nitrate. *Lime saltpeter,* or *Norwegian saltpeter,* is calcium nitrate ($Ca(NO_3)_2 \cdot 4H_2O$). It is made from limestone, and is used to make fertilizer, matches, explosives, and other chemicals. Barium nitrate ($Ba(NO_3)_2$) is sometimes called *barya saltpeter.* It is used to make barium oxide (BaO) and green fireworks. Emily Jane Rose

Saltwater fish. See Fish (Where fish live; pictures).

Saluda Dam, *suh LOOD uh,* is among the 30 largest earth-fill dams in the United States. It is part of a hydroelectric power project on the Saluda River, 10 miles (16 kilometers) upstream from Columbia, South Carolina. Saluda Dam is 211 feet (64 meters) high and 8,650 feet (2,637 meters) long at the top. It contains 11 million cubic yards (8.4 million cubic meters) of earth. The dam was completed in 1930 at a cost of $6 million. T. W. Mermel

Saluki, *suh LOO kee,* also called *gazelle hound,* is believed to be the oldest purebred dog. It was developed in the Middle East about 5000 B.C. One of the swiftest dogs, the Saluki was once teamed with hawks for hunting gazelles. The hawk struck the prey, and the Saluki held it down until the hunters arrived.

The Saluki has a smooth, soft coat, with fringes of long hairs on its ears, legs, and thighs. It is 23 to 28 inches (58 to 71 centimeters) high at the shoulder and weighs about 60 pounds (27 kilograms).

Critically reviewed by the American Kennel Club

See also **Dog** (picture: Hounds).

© Gerard Lacz, Animals Animals

Salukis have smooth coats with predominantly white, reddish-brown, or black coloring. The dogs' long legs and streamlined bodies help make salukis one of the swiftest of all dog breeds.

Salute is a gesture of greeting that generally expresses respect or courtesy. Various types of military salutes show respect to an officer, a flag, or a country.

Military hand salutes. According to United States Army regulations, soldiers must use the hand salute at a distance of not more than 30 paces and not less than 6 paces. They raise the right hand snappily to the forehead, with the palm down and the index finger at the peak of the cap. The forearm is held at a 45° angle. Soldiers must look directly at the officer when saluting, and the officer must return the salute if possible. Soldiers must salute, whether or not they are wearing any head covering. Navy personnel must be wearing head covering when they salute. Aboard ship, sailors salute an officer only at the first meeting during the day, except when reporting in the course of duty. Officers and enlisted personnel salute the flag and officer of the deck when boarding or leaving their ship. Only soldiers in good standing may salute. A prisoner may not salute.

In other countries, military salutes are similar to those of the United States. British soldiers salute with their palms out, rather than down. Some dictatorships adopted salutes that all persons had to use. In Fascist Italy and Nazi Germany, civilians and soldiers saluted by holding their right arms out at an angle, palms down.

Ann Alexander Warren

See also **Flag** (Saluting the flag).

Salvador, *SAL vuh DAWR* (pop. 2,050,133; met. area pop. 2,424,878), also referred to as Bahia, is a large city in Brazil. The city serves as the capital of the state of Bahia and is also a busy Atlantic port. It lies on Todos os Santos Bay. For the location of Salvador, see **Brazil** (political map).

Salvador's port lies along a beach at the foot of a steep cliff. Elevators and winding roads lead up the cliff from older sections of the city to newer ones. Palm trees and white buildings with red tile roofs line the streets. Salvador is known for its many highly decorated churches, some of which date from the 1700's.

Salvador's main industries include food and tobacco processing, textile manufacturing, petrochemical production, and the production of platforms and other equipment for oil exploration. Leading exports of Salvador include cacao, fruit and fruit juices, petroleum, sugar, tobacco, and vegetable oils. Salvador is the home of the University of Bahia and the Catholic University of Salvador.

Salvador served as the capital of the Portuguese colony of Brazil from 1549, when the city was founded, until 1763. Since 1940, industrial development programs have stimulated the rapid growth of Salvador.

Hilary J. D. Mackenzie

Salvador, El. See El Salvador.

Salvage, *SAL vihj,* is money or goods paid to those who save ships or cargo abandoned at sea. Help that is given to a vessel in distress or danger is called *salvage service.* In the United Kingdom, salvage is granted only for acts on the high seas. In the United States, courts allow salvage for saving goods, ships, and life on inland waters as well as on the high seas.

The *salvor* is a person who helps to save a ship other than the one on which the person sails. Salvors cannot collect salvage for helping to save their own ship. Salvage can be collected only for saving a ship that sails under its own power, or a moving barge. It is not granted in the case of a barge or other floating structure moored to a shore or dock. The danger from which a ship is salvaged must be real, not something that might happen. The ship saved must be brought to a safe place, ready to be returned to its owner for repair.

Some countries have fixed by law the amounts to be paid in salvage cases. The United States and the United Kingdom have no such laws. American and British courts grant salvage claims based on conditions under which the act has been performed. It is usual to pay amounts substantially more than those generally paid to officers and crew members for regular work.

Division of salvage among the salvors also rests on the decision of the courts. The master's share is usually double that of the mate. The mate's share is usually double that of a crew member. The share of the crew that does the work and sails the salvaged ship back to port is usually double that of those who remain aboard the

salvor vessel. The greatest amount of salvage that was ever recovered from a sunken ship was the 40 million pounds of sterling recovered from the British cruiser *Edinburgh*. The ship was torpedoed by German warships in the Barents Sea in 1942. In 1981, British divers retrieved about 5 tons (4.5 metric tons) of gold bars from the *Edinburgh*.

The term salvage is also used to describe goods recovered from emergencies on land. These emergencies include floods or fires. Robert F. Marx

See also **Diving, Underwater; Flotsam, jetsam, and lagan.**

Salvation. See **Religion** (A doctrine of salvation); **Protestantism** (Faith and grace); **Roman Catholic Church** (Sin, the Incarnation, and salvation).

Salvation Army is an international Christian religious and charitable organization. It is set up and operated on a military pattern, and its leaders have the ranks of military officers. The Salvation Army works to foster a love of God and to provide for the needy. The organization offers its services to people of any race, creed, sex, or age.

Services and activities. The basic unit of the Salvation Army is the corps community center. Each center is directed by a commanding officer who administers both religious and social service activities. These centers conduct a varied program, providing religious services, counseling, moral education, and other social services. In addition, the Salvation Army operates a variety of institutions, including hospitals, drug and alcohol rehabilitation centers, camps, boys and girls clubs, senior citizen residences and clubs, and day-care centers. It also provides education programs for unwed mothers, family assistance, and aid to prisoners and their families. The Salvation Army includes many musicians who use music as a way to preach the gospel.

Diane E. Tolcher, The Salvation Army

A Salvation Army volunteer visits a nursing home. Other army welfare and community services include work programs and housing for the poor.

Diane E. Tolcher, The Salvation Army

Salvation Army musicians raise funds at Christmastime by playing on street corners. The money collected in the red kettle purchases food, clothing, and shelter for the needy.

Much of the worldwide service of the Salvation Army is given to people in less developed countries. These services include education, basic needs, vocational instruction, and disaster relief.

History. William Booth, a Methodist minister, founded the Salvation Army in London in 1865. That year, he began conducting meetings to bring the gospel of Jesus Christ to the people of London's East End. His work was well received, and he organized a group known as the Christian Mission. In 1878, the group changed its name to the Salvation Army. The organization soon spread outside the United Kingdom. It was established in the United States in 1880.

Today, the Salvation Army works in over 85 countries. About 25,000 men and women serve as Salvation Army officers. Each officer is an ordained minister. The Salvation Army has more than 14,000 corps community centers located throughout the world. There are about 420,000 members in the United States. International headquarters are in London. United States headquarters are located in Verona, New Jersey.

Critically reviewed by The Salvation Army

See also **Booth, Evangeline Cory; Booth, William.**

Salvia, *SAL vee uh,* is a group of about 700 species of plants that grow in temperate and warm regions. Salvias have two-lipped flowers that range in color from white and pale yellow to blue, purple, and scarlet. Gardeners use many species as ornamentals, including the *scarlet sage,* which often has brilliant red flowers. Scarlet sage is native to Brazil but is grown in other parts of the

WORLD BOOK illustration by Christabel King

Scarlet sage, a type of salvia, often appears in gardens.

world. The *garden sage* that people use to flavor foods is a salvia. See also Sage. Kenneth A. Nicely

Scientific classification. Salvias are in the mint family, Lamiaceae or Labiatae. They make up the genus *Salvia*. The scarlet sage is *S. splendens*. The garden sage is *S. officinalis*.

Salzburg, *SAWLZ buhrg* or *ZAHLTS boork* (pop. 143,978), is a city located in the mountains of northwestern Austria. For location, see **Austria** (map). Salzburg is best known for its annual music and theater festivals. Wolfgang Amadeus Mozart, one of the world's greatest composers, was born in Salzburg. Salzburg is the capital of Salzburg province. William J. McGrath

SAM. See **Guided missile** (Surface-to-air missiles).

Samara, *suh MAHR uh* (pop. 1,170,800), is a major Russian manufacturing center and Volga River port (see **Russia** [political map]). A large oil field and rich grain fields lie nearby. Samara's large hydroelectric power plant includes a dam across the Volga. Manufactured products include aircraft, food products, and locomotives. Samara was renamed Kuybyshev in 1935, when Russia was a republic of the Soviet Union. It was renamed Samara in 1991, shortly before the Soviet republics became independent. Zvi Gitelman

Samaria, *suh MAIR ee uh,* was the name of a city and its surrounding region in ancient Canaan (later called Palestine). King Omri built Samaria in about 800 B.C. He made it the capital of the kingdom of Israel and named it after Shemer, who owned the land where it was built.

Assyria conquered Samaria in 721 or 722 B.C., after a siege of three years. In 331 B.C., the city fell to Alexander the Great. The kingdom of Judah attacked and destroyed the city in 128 B.C. It was later rebuilt by Herod the Great, who called it *Sebaste*. Excavations begun in 1909 have yielded many ancient treasures. According to tradition, Saint John the Baptist is buried in Samaria. Remains of the Crusaders' church, built in the 1100's, have also been found. The site of Samaria is in the West Bank region of Southwest Asia. Peter Gubser

Samaritans, *suh MAR uh tuhnz,* were citizens of ancient Samaria. The Assyrians destroyed Israel in 721 or 722 B.C. and took the ablest Israelites to Assyria as captives. The Assyrian ruler then forced people from eastern Assyria to settle in the region of Samaria (see **Samaria**). Many of the new settlers intermarried with the remaining Israelites. People with this mixed ancestry and mixed religion came to be called *Samaritans*.

The Samaritans adopted the *Torah,* the first five books of the Hebrew Bible, as their scripture. But the Hebrews to the south refused to associate with them and considered their religion inferior. When the Hebrews rebuilt their temple, they refused help that the Samaritans offered. Eventually, the Samaritans built a temple of their own, but it was destroyed in 128 B.C.

In Jesus's time, the Jews looked down on the Samaritans as foreigners. Jesus told a story about the Good Samaritan who aided a Jew who was robbed and injured by thieves after the man had been refused assistance by other Jews (Luke 10:30-34). The story is ironic because the Samaritans were not expected to show sympathy toward Jews. The same theme appears in the story of Jesus's healing of 10 lepers. Only the "foreign" Samaritan leper returned to thank Jesus (Luke 17:11-19).

About 500 Samaritans now live in two communities in the state of Israel. They are the only living descendants of the Biblical Samaritans. Richard A. Edwards

Samarium, *suh MAIR ee uhm* (chemical symbol, Sm), is one of the rare-earth metals. Its *atomic number* (number of protons in its nucleus) is 62. Its *relative atomic mass* is 150.36. A chemical element's relative atomic mass equals its *mass* (amount of matter) divided by $\frac{1}{12}$ of the mass of carbon 12, the most abundant form of carbon. The density of samarium is 7.536 grams per cubic centimeter at 25 °C (see **Density**). The metal is named after the Russian engineer Colonel Samarski. Paul Émile Lecoq de Boisbaudran of France discovered samarium in 1879.

Samarium is best separated from other rare earths by ion-exchange or solvent-extraction processes. It has a silver color and slowly oxidizes in air. The common oxide Sm_2O_3 has a pale yellow color and is rapidly soluble in most acids. The metal melts at 1074 °C and boils at 1794 °C. Alloys of samarium and cobalt are excellent magnetic materials and have many commercial uses. Larry C. Thompson

See also **Element, Chemical** (table); **Rare earth**.

Samarqand, *SAHM uhr KAHND* (pop. 515,000), is the second largest city and former capital of Uzbekistan. Samarqand, also spelled Samarkand, is an educational and manufacturing center. Factories there make radio components, silk goods, superphosphate, and tractor parts. Samarqand occupies the site of ancient Maracanda. Alexander the Great destroyed Maracanda in 329 B.C. In the 1300's, the Mongol conqueror Timur (also called Tamerlane) chose the city as his capital. See **Uzbekistan** (map). Zvi Gitelman

Sami, *SAH mee,* are the native people of northernmost Norway, Sweden, Finland, and the Kola Peninsula in northwest Russia. They were formerly known as Lapps, but they prefer the name Sami. There are about 70,000 Sami. About 40,000 Sami live in Norway, about 20,000 in Sweden, about 7,000 in Finland, and about 2,000 in Russia. In the 1900's, the Sami began to establish a common cultural identity and to gain political power.

Traditionally, the Sami pursued a nomadic lifestyle, by reindeer herding or by hunting, fishing, and trapping. Some Sami still travel with reindeer as the herds migrate between summer and winter pastures. Howev-

© Bryan and Cherry Alexander, Bruce Coleman Inc.

A Sami bride and groom and their guests wear traditional costumes during the wedding celebration. Most Sami usually wear modern styles of clothing.

er, fewer Sami make their living in the traditional ways, and those who do use such modern equipment as snowmobiles and helicopters. Today, most Sami live in towns and villages. Some live and work in cities.

Anthropologists have distinguished four main groups of Sami, based on traditional economic activities. These groups are the Coastal Sami, the Mountain Sami, the Forest Sami, and the Eastern Sami. Coastal Sami traditionally fished along the western and northern coastal areas of Norway. Mountain Sami herded reindeer in the mountain range that joins Norway and Sweden. Forest Sami lived in northeast Sweden and northern Finland. They depended more on hunting and trapping than on reindeer herding. Eastern Sami include two groups, the Skolt Sami and the Kola Sami. In winter, the Eastern Sami established a home that served as a base for short-distance fishing trips. During the other seasons, the Eastern Sami migrated while herding reindeer and sheep.

© Bryan and Cherry Alexander

Mountain Sami herd reindeer in the mountains of northern Norway and Sweden. They use both modern equipment, such as snowmobiles, and traditional gear, such as reindeer hide tents.

Language and culture. The languages of the Sami are related to Finnish and Estonian. Around ten Sami dialects are known, though some of them are no longer spoken. The most widely spoken dialect is North Sami, which is spoken by about 30,000 people in Norway.

The governments and the other peoples in the countries where the Sami live sometimes regarded Sami customs as backward and pagan. Such attitudes began to change in the mid-1900's. Traditional Sami clothing and the traditional song form, the *joik,* have become sources of Sami pride. Many people admire the traditional Sami respect for land and the environment.

Religion. Ancient Sami religion involved a kind of *animism*—that is, belief in an extensive world of spirits. In a ritual performed when a bear was killed, for example, the hunters and others in their community welcomed the dead bear and asked for forgiveness for taking its life. The Sami also believed that illness, a lack of animals to hunt, and other problems in the human world might originate in the spirit world. Sami religious leaders called *shamans* were believed to have contact with the spirit world. Shamans would sometimes beat drums to foretell the future.

In the 1500's, the governments of the countries where the Sami lived began to convert them to Christianity. The Sami in the east joined the Russian Orthodox faith. The Sami in the west became members of the state Lutheran churches. However, some elements of traditional Sami religion lasted through the 1700's, most notably the use of the shaman drum.

Land and climate. The Sami call their land Sapmi. It extends across the northernmost parts of Norway, Sweden, Finland, and the Kola Peninsula in Russia. The southern boundary of east and central Sapmi lies roughly along the Arctic Circle. Western Sapmi extends southward through the mountains of Norway and Sweden to about 62 degrees north latitude. The part of Sapmi that lies above the Arctic Circle is known as Lapland.

Winters last from October to May. In December, there is almost no daylight. The short summer, however, can be warm, and the days become extremely long. Sap-

mi has many mountains, but there are also dense forests of pine, willows, and fir, dotted with lakes and cut through by rivers.

History. Scholars believe that the ancestors of the Sami and the Finns came to the region more than 5,000 years ago. They lived by hunting and gathering food. The ancestors of the Sami, who lived in the inland and more northern areas, remained hunters and gatherers. The ancestors of the Finns, living in the coastal regions, adopted agriculture and the raising of animals. The Sami once occupied much of Finland and Scandinavia, far south of the current borders of Sapmi.

During the Viking Age (the late 700's to about 1100), Scandinavians from the south began to trade with the Sami and to take *tribute* (money paid for peace) from them. The Sami gradually retreated farther north, but they were still subjected to taxation.

Beginning in the 1500's, the increased northward expansion of Norway (then a part of Denmark), Sweden, and Russia led to conflict with the Sami. The Scandinavians and Russians treated the Sami as inferior people, and they claimed dominion over Sami lands. The Strömstad Treaty of 1751, which defined the Norwegian-Swedish border, granted the Sami the right to cross national borders freely for the purpose of reindeer herding. But settlement in the northern lands continued.

In the late 1800's and early 1900's, Scandinavian and Russian governments attempted to suppress Sami culture and to integrate the Sami into their societies. For example, Sami children were required to attend state-run schools in which the use of Sami languages was forbidden. In reaction, the Sami began organizing to defend their way of life.

By the mid-1900's, the governments of Finland, Norway, Russia, and Sweden had abandoned policies that suppressed Sami culture. However, they still did not recognize Sami land rights. In 1979, for example, Norway began building a dam at Alta, in the north, that would flood land used by the Sami for reindeer herding. The Sami and others protested vigorously, but the government built the dam despite the protests.

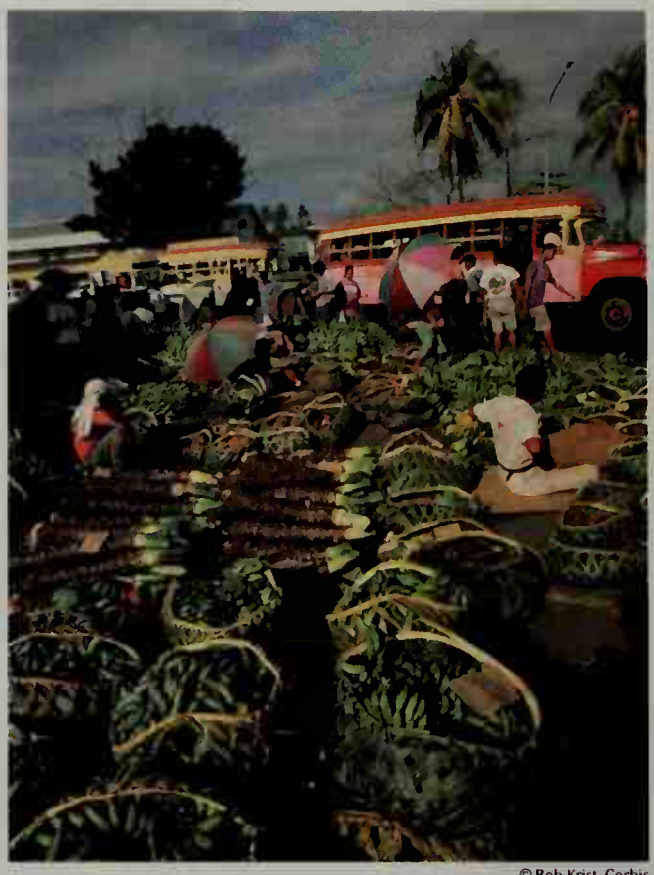
In the late 1900's, the Sami declared themselves a single people who live within four political nation-states. They created a Sami flag and anthem. Finland, Norway, and Sweden established Sami parliaments with the intention of giving the Sami a greater say in matters affecting their economic and cultural affairs. John Lindow

See also **Arctic; Finland; Lapland; Norway; Sweden.**

Samoa, *suh MOH uh,* is an independent island country in the South Pacific Ocean. It lies in the western part of the Samoa Islands chain about 1,700 miles (2,740 kilometers) northeast of New Zealand. American Samoa, a United States territory, occupies the eastern part of the chain (see **American Samoa**). Samoa is one of the smallest countries. It consists of two main islands, Upolu and Savai'i, and several smaller islands. Apia, a city that has about 36,000 people, is the capital and only city.

Samoans are Polynesians. Most live by raising their own food on small plots of land.

Polynesians have lived in Samoa for at least 2,000 years. The first Europeans landed there in the 1700's, and Germany took control in 1900. During World War I (1914-1918), New Zealand occupied the islands. It ruled them until the islands gained independence as Western Samoa in 1962. The noted writer Robert Louis Stevenson lived in Samoa for several years. He died there and was buried near Apia in 1894. Stevenson's house, which was called Vailima, is now the residence of the head of state.



© Bob Krist, Corbis

An outdoor market in Apia, Samoa's capital and only city, sells bananas and other produce. The country's economy is based on agriculture, and bananas are one of the chief crops.

Government. Samoa's head of state, Malietoa Tanumafili II, holds office for life. When he dies, the parliament, which is called the Fono, will elect a head of state for a five-year term.

Voters elect the 47 members of the Fono to three-year terms. Only *matai* (heads of Samoan family groups) are eligible to serve on the Fono. The Fono members elect

Facts in brief

Capital: Apia.

Official languages: Samoan and English.

Area: 1,093 mi² (2,831 km²). *Greatest distances*—east-west, on each of the two main islands, 47 mi (76 km); north-south, 15 mi (24 km) on Upolu, 27 mi (43 km) on Savai'i. *Coastline* (total for both islands)—about 230 mi (370 km).

Elevation: *Highest*—Mount Silisili (on Savai'i), 6,095 ft (1,858 m). *Lowest*—sea level.

Population: *Estimated 2002 population*—187,000; density, 171 per mi² (66 persons per km²); distribution, 79 percent rural, 21 percent urban. *1991 census*—161,298.

Chief products: *Agriculture*—bananas, cacao, coconuts.

Flag: The flag has a red field with a blue canton in the upper left-hand corner. Five white stars on the canton symbolize the Southern Cross constellation. Adopted in 1962. See **Flag** (picture: Flags of Asia and the Pacific).

Money: *Basic unit*—tala. One hundred sene equal one tala.

the prime minister. The prime minister selects a cabinet from among Fono members. All people 21 years old and older may vote.

The prime minister and cabinet actually run the government of Samoa. Laws passed by the Fono do not go into effect until the head of state approves them. A *pulenu'u* (head chief) is appointed to represent the government in each village. There are two political parties in the country, the Human Rights Protection Party and the Samoa National Development Party.

People. Most Samoans are of full Polynesian descent. About 10 percent of the people are of mixed Samoan and European descent. A few Europeans, Chinese, and people from other Pacific islands live in Samoa. The people speak *Samoan,* a Polynesian language. Many Samoans also speak English.

Samoans live simply, much as their ancestors did. Samoan life centers around the family. The people live with their relatives in extended family groups that are called *aiga.* The aiga elects a matai who serves as head of the family.

Many people live in open-sided *fale* (houses) that have a thatched roof supported by poles. But cement-block houses with sheet-metal roofs are becoming more common. Most Samoan men wear a shirt and a *lava-lava,* a piece of cloth wrapped around the waist like a skirt. Most of the women wear a long lava-lava and an upper garment called a *puletasi.*

Samoans enjoy singing and dancing, which serve as both a form of recreation and a method of handing down history and tradition. Samoans also play their own version of cricket, a game they learned from the English missionaries. They play cricket with teams that may have from 10 to 300 players, compared to 11 players in a normal cricket game.

Almost all Samoans are Christians. The most important religious groups in the country are the Congregational, Methodist, and Roman Catholic.

Samoa provides good medical care, and the people are generally healthy. Most districts have government hospitals that provide free care.

Most Samoans can read and write Samoan. About half can read and write English. Education is free. Children are required to attend elementary school. The government operates elementary schools in most villages and also has a few high schools. Some lessons are given by radio in all government schools. Many children attend mission schools. Samoa also has two colleges and a national university. Some Samoan students go overseas for further schooling.

Land. The islands of Samoa were formed by erupting volcanoes. A volcano on Savai'i is still active. It last erupted from 1905 to 1911, covering part of the island with lava rock that is still bare. The islands are fringed with coral reefs.

The island shores are lined with tall, graceful coconut palm trees. The rocky, reddish-brown soil near the coasts is fertile enough to produce bananas; *taro,* a plant with an edible underground stem; and *cacao,* a tree whose seeds are used to make chocolate and cocoa. Further inland, heavy rains have *leached* the soil (dissolved the minerals and washed them away). Few food crops can grow there. Tropical rain forests cover the high volcanic peaks at the center of the islands.

The climate is tropical and humid, but the southeast trade winds make it mild. Temperatures seldom rise above 85 °F (29 °C) or fall below 75 °F (24 °C). Rainfall ranges from about 70 inches (180 centimeters) a year on the northwest coast to over 150 inches (381 centimeters) in the southeast. The most pleasant months are from May to September, when the temperatures and rainfall are lowest.

Economy is based on agriculture, and about 70 percent of the people are farmers. The chief food crops are bananas, coconuts, tropical fruit called *breadfruit,* and taro. The people also raise pigs and chickens and catch fish for food. They export some bananas, cacao, and *copra* (dried coconut meat).

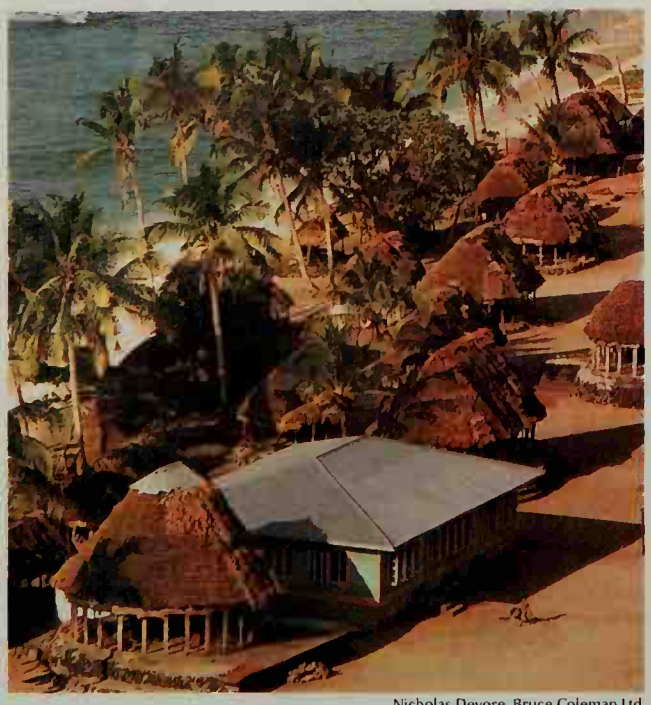
The annual average income in Samoa is very low by world standards. Most Samoans raise much of their own food, build their own houses, and make most of their own clothing.

Most of the employed people in Samoa work for the government. Some others work for traders in Apia or for the missions. Samoa has few industries. It imports some manufactured goods, processed foods, and petroleum products from Australia, Britain, Germany, Japan, New Zealand, and the United States.

Most Samoan villages are linked by roads. Small boats travel regularly between the islands. Samoa's airline, called Polynesian Airlines, flies to American Samoa, Tonga, and Fiji. Oceangoing ships dock at Apia, Samoa's only port.

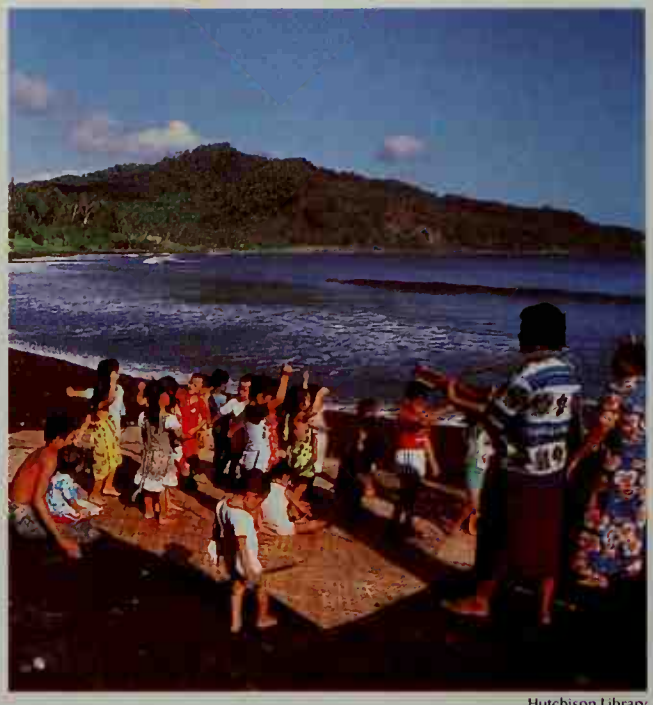
History. People have lived in Samoa for at least 2,000 years, probably coming there from what are now Fiji and Vanuatu. The Samoans drove out invaders from the Tonga Islands and began forming their own nation about 1,000 years ago. Many chiefs ruled the people until a woman, Salamasina, united them in the 1500's.

WORLD BOOK maps



Nicholas Devore, Bruce Coleman Ltd.

Many Samoan houses have thatched roofs and open sides because of the country's warm, pleasant climate.



Hutchison Library

Polynesians make up about 90 percent of the population of Samoa. Samoan life centers around family activities.

Jacob Roggeveen, a Dutch explorer, was the first European to reach the Samoa Islands. He arrived in 1722. But few Europeans visited the islands until the first mission was established in Savai'i in 1830. Once the Samoans accepted the missionaries, whaling and trading ships began making regular stops in the islands.

Two royal families ruled different parts of the Samoa Islands during the mid-1800's, and they fought among themselves over who would be king. Britain, Germany, and the United States supported rival groups. In 1899, the three countries agreed that Germany and the United States would divide the islands, and Germany took control of the western islands in 1900. Germany improved farm production and also expanded the economy.

In 1914, during World War I, a military force from New Zealand occupied German Samoa. After the war, the League of Nations gave New Zealand a *mandate* (order) to govern what was then called Western Samoa.

New Zealand's rule began disastrously. An influenza epidemic struck Western Samoa in 1918, and about one-fifth of the people died. The New Zealand government became more and more unpopular in the 1920's. Some Samoans joined an organization called the Mau (testimony) movement, which favored Samoan traditions and opposed rule by New Zealand. The Mau movement urged nonviolent resistance. Samoans began to refuse to obey laws or to cooperate with the government. They continued their civil disobedience activities until 1936, when New Zealand officials met some of their demands.

After World War II (1939-1945), the United Nations made Western Samoa a trust territory and asked New Zealand to begin preparing the islands for independence. In 1957, members of the Fono were elected for the first time and Samoan members controlled it. A cabinet headed by a Samoan prime minister gained executive powers in 1959. In 1961, the people voted to accept a new constitution. Western Samoa became independent on Jan. 1, 1962. It joined the Commonwealth of Nations in 1970 and the United Nations in 1976. It changed its name to Samoa in 1997. Michael R. Ogden

See also **Apia**.

Samoa Islands, *suh MOH uh,* is a chain of islands in the South Pacific Ocean. This chain was once called the Navigators Islands because of the fine canoes built by the Samoans. The Samoa Islands cover 1,173 square miles (3,039 square kilometers) and have a population of about 193,000. Almost all of the people are Polynesians.

The Samoa Islands are divided into two political units. The eastern islands, which include Tutuila and several smaller islands, are part of American Samoa, a possession of the United States. The United States acquired the islands of American Samoa in stages between 1900 and 1925. The western islands of the chain—which consist of Savai'i, Upolu, and several smaller islands—make up the nation of Samoa. Samoa, formerly called Western Samoa, has been an independent nation since 1962.

Tutuila has the only good harbor in the islands. The United States had a naval base there until 1951.

Nearly all the Samoa Islands are volcanic formations, and coral reefs surround most of them. Rich forests and flatlands slope gently toward the sea. The climate of the islands is hot and rainy. Robert C. Kiste

See also **American Samoa; Samoa.**

Samoset, *SAM oh seht* (1590?-1655), was one of the first American Indian friends of the Pilgrim settlers of the Plymouth Colony. He was a chief of the Pemaquid Indians. Samoset probably first came into contact with English people when he met some fishermen along the coast of Maine. He learned a little English from them. In March 1621, he startled the Plymouth colonists by appearing on the street and welcoming them in broken

English. He later introduced the colony's leaders to Massasoit, an Indian chief of the Plymouth area, and to Squanto, an Indian leader whose English was better than Samoset's. In 1625, Samoset made what is believed to be the first deed of Indian land to English colonists in Maine. He transferred 12,000 acres (4,856 hectares) of his tribe's land to John Brown, a settler. James Axtell

See also **Massasoit; Squanto.**

Samothrace, *SAM uh THRAYS,* also called Samothraki (pronounced *SAH maw THRAH kee*), is a Greek island that is often mentioned in Greek mythology. The island covers 69 square miles (178 square kilometers) in the Aegean Sea (see **Greece** [terrain map]). It has a population of 2,871. Tourism and the production of olives and fruit are the leading industries. Ruins found on Samothrace date from 500 B.C. In 1863, the famous statue of the Winged Victory of Samothrace was found on the island (see **Winged Victory**). John J. Baxevanis

Samoyed, *SAM uh YEHD,* is a dog bred by the Samoyed peoples of northern Siberia. The Samoyed is used to guard reindeer herds and to pull sleds. The dog is intelligent, has a pleasant disposition, and is fast. It has long, white hair and a muscular body. The Samoyed stands between 19 and 23 $\frac{1}{2}$ inches (48 and 59.7 centimeters) high at the shoulder and weighs from 35 to 60 pounds (16 to 27 kilograms).

Critically reviewed by the Samoyed Club of America

See also **Dog** (picture: Working dogs); **Sled dog.**

Sampan, *SAM pan,* is a small boat used chiefly in rivers and harbors in China, Japan, and nearby islands. It usually has a cabin with a roof made of mats. Large numbers of people use these boats for homes. They are rowed with one or more oars, and some have a sail.

Octavia N. Cubbins

See also **Shelter** (picture: Oriental houseboats).

Sampler is a small square or strip of cloth covered with sample patterns of needlework. The term *sampler* comes from the Latin word *exemplar,* meaning a *pattern.* Adults first used samplers to record patterns of embroidery or lace. But as early as the 1500's, young girls made samplers for practice or to show their skill.

Sampler (1820) by Sarah Carson; Philadelphia Museum of Art, the Whitman Sampler Collection, given by Pet Inc.

A colorful sampler, embroidered as a school project by a Pennsylvania girl, is a prized example of American folk art.

Samplers were made of colored silks stitched on wool or linen canvas, or of lace patterns on closely woven linen. The girls often embroidered letters, numerals, quotations, and verses to gain experience with different techniques. Sometimes a girl would add her name, age, and the date the sampler was made. Many samplers had intricately embroidered birds, flowers, patterns of Bible verses, and even tiny human figures.

Samplers are mentioned in the literature and wills of the early 1500's. Many styles and shapes were produced in Europe and the United States until the end of the 1800's. Today, samplers featuring pictorial elements and those dating before 1860 are especially prized by museums and collectors. Beatrix T. Rumford

Sampling. See Statistics (Sampling).

Sampras, Pete (1971-), is an American tennis champion. Sampras has won 13 grand slam titles, the most by any man in tennis history. The grand slam consists of four annual tournaments—the All-England (Wimbledon) Championship, the United States Open, the French Open, and the Australian Open. In 1990, Sampras became the youngest man to win the United States Open title. He also won the tournament in 1993, 1995, and 1996. He won the Wimbledon title in 1993, 1994, 1995, 1997, 1998, 1999, and 2000, the first American man to win the title at least three years in a row. Sampras also won the Australian Open in 1994 and 1997.

Sampras is noted for his strong all-around game, especially his powerful serve, which can reach speeds of about 130 miles (210 kilometers) per hour. His game is best suited to fast court surfaces. Sampras is a fierce competitor, but has been praised for his sportsmanship.

Pete Sampras was born in Washington, D.C., and grew up in California. He became a professional player in 1988. Donna K. Doherty

See also **Tennis** (picture: Modern men tennis stars).

Sampson, Deborah (1760-1827), served in the Revolutionary War in America disguised as a man. In May 1782, she enlisted in the 4th Massachusetts Regiment of the American army as Robert Shurtleff. Sampson fought in several battles and was wounded at least twice. She hid a leg wound so doctors would not discover she was a woman. About June 1783, Sampson was hospitalized in Philadelphia because of a high fever, and her identity was discovered. General George Washington ordered that she be given an honorable discharge.

Deborah Sampson was born in Plympton, Massachusetts. Before enlisting, she had been a teacher. A book about her army experiences, *The Female Review,* was published in 1797. In 1805, the United States Congress awarded her a pension because of her military service and wounds. William Morgan Fowler, Jr.

Sampson, William Thomas (1840-1902), an American naval officer, became involved in a dispute over the Battle of Santiago during the Spanish-American War in 1898. In April, he commanded the North Atlantic Squadron, which tried to stop the Spanish fleet from entering Santiago de Cuba, a Cuban port. But the Spaniards slipped into Santiago, and Sampson blockaded the port. On July 3, the Spanish fleet, under Admiral Pascual Cervera y Topete, left the safety of the port and was destroyed in battle.

Sampson and his flagship had left the squadron to

meet with army commanders when the Battle of Santiago began. He quickly returned to his ships. But because Commodore Winfield Schley gave the first orders and played a leading role in the battle, newspapers credited him with the victory. A public quarrel occurred over which officer was responsible for the victory. A naval court of inquiry criticized Schley, but neither Congress nor the public rewarded Sampson's performance.

Sampson was born in Palmyra, New York. He graduated from the United States Naval Academy in 1861 at the head of his class. Lewis L. Gould

Samson was a folk hero of ancient Israel, famed for his great strength. His story is told in the Old Testament, Judges 13-16. The story reflects the beginnings of Israel's struggle with the Philistines in the 1000's B.C.

Consecrated before his birth by his mother's vow, Samson was forbidden to drink wine, eat impure food, or cut his hair. He fell in love with a Philistine woman who was unfaithful to him. So he set fire to the fields of her people. When the Israelites handed him over for punishment, he broke loose and killed 1,000 Philistines with the jawbone of an ass. Later, the Philistines tried to capture him in Gaza by locking the city gates. But he tore out the gates and carried them away.

Samson's downfall came when he fell in love with a second Philistine woman, Delilah. She learned that the secret of his strength lay in his hair, and she had his head shaved while he slept. Samson was easily taken, blinded, and made to work as a slave. At the festival of the god Dagon, when the temple was filled with people, the Philistines led Samson in so the crowd could make fun of him. But his hair had grown back, and he was strong again. He seized the pillars that supported the roof and pulled the building down, killing himself and thousands of his enemies. J. Maxwell Miller

See also Delilah.

Samuel, Books of, are two books of the Bible, called I Samuel and II Samuel. They were originally a single book. I Samuel includes stories about the leader Samuel and about how Samuel anointed Saul to be the first king of Israel. The book describes Saul's reign and then David's rise to the throne. The second book is a history of David's reign.

Most scholars believe that the Books of Samuel are a combination of at least two earlier works. The books do not simply tell stories about heroes and kings. They show that when the king obeys God's will, then the king and the nation prosper. If the king disobeys God, then he is punished and the kingdom suffers. See **Bible** (Books of the Hebrew Bible).

The Books of Samuel as we know them were edited after the destruction of the kingdom of Judah in 587 or 586 B.C. After this defeat, the Jews had no king. They wanted to understand why God gave them a monarchy and why God took it away.

Many Jews believed that their homeland would be restored to them and that they would have a chance to rebuild their nation. In the Books of Samuel, they tried to find lessons for the new nation in the experience of the past. Eric M. Meyers

Samuelson, Paul Anthony (1915-), is an American economist who won the 1970 Nobel Prize in economics. In *Foundations of Economic Analysis* (1947), Samuelson showed the underlying unity of many economic principles and encouraged the use of mathematics in economic analysis. He revolutionized the teaching of economics by presenting the most advanced economic thinking at the introductory level. His college textbook *Economics: An Introductory Analysis,* first published in 1948, became the largest-selling economics textbook in the world.

Samuelson was born in Gary, Indiana. He taught economics at the Massachusetts Institute of Technology from 1940 to 1986. In the early 1960's, Samuelson served as economic adviser to Presidents John F. Kennedy and Lyndon B. Johnson. Barry W. Poulson

Samurai, *SAM u ry,* were members of the hereditary warrior class in Japan. The early samurai defended the aristocrats' estates in the provinces. The samurai wore a protective helmet and armor. They used two curved swords, one long and one short.

During the 1000's and 1100's, the samurai began to develop a tradition of values and personal conduct. They valued horsemanship, skill with the bow, strong self-discipline, and bravery. Above all, they prized total obedience and loyalty to their lords, and personal honor. If the samurai were dishonored, they would consider it a duty to commit ritual suicide.

The samurai became powerful after Yoritomo, the

Painting (1500's-1600's) by an unknown Japanese artist; Granger Collection

A samurai, *above,* wipes blood from his sword after a battle. The samurai were members of Japan's warrior class. They were known for their self-discipline and for their bravery in combat.

Minamoto clan leader, established the first *shogunate* (warrior government) in the late 1100's. Their military strength and administrative organization provided a foundation for a long period of relative peace.

In the 1300's to 1500's, under the weak Ashikaga shogunate, the samurai became leaders of Japanese society but battled among themselves. The greatest of the warriors, called *daimyo,* controlled vast territories.

After a period of control by local warlords, Japan was reunited in the late 1500's. In 1603, the powerful Tokugawa shogunate was established. The samurai then influenced every part of life until the mid-1800's, when the Japanese emperor regained full control. Jeffrey P. Mass

See also **Hara kiri; Minamoto Yoritomo; Shogun.**

San, *sahn,* are a people of Africa, most of whom live in the Kalahari Desert region of Botswana and Namibia. The San are sometimes called Bushmen, but many anthropologists consider the word insulting. Another name for the San, Basarwa, is used mainly in Botswana. The San speak *Khoisan* languages, which are characterized by clicking sounds.

In the past, the San hunted animals and gathered wild plants for food, much as prehistoric people did. Today, however, only a few San follow their traditional way of life. Much of the San's land has been taken over by other Africans, including many whites of European descent. Many San now live in permanent settlements, where many depend on welfare. Others work on cattle farms. Some have worked for the South African military.

Traditionally, San families lived in groups that averaged about 25 people. Each group occupied its own territory. During part of the year, the group moved from place to place within its territory. But at other times, the group stayed for many weeks near a water source with other groups. Group members built shelters of branches and grass.

Wild desert plants provided the San with most of their food, which included berries, melons, nuts, roots, and seeds. The women usually gathered the plants while the men hunted animals with bows and poison-tipped arrows. After killing a large animal, the hunters would share the meat with the whole group. Anthropologists believe that even in the rugged Kalahari region, the San needed only about two hours a day to hunt and collect their food.

No one knows where the San first came from, but they lived throughout southern and eastern Africa for thousands of years. Bantu-speaking black tribes began to move into these regions around A.D. 300, and Europeans arrived in the 1600's. In time, no San remained in eastern Africa or in the richer lands of southern Africa. But they continued to live in the Kalahari Desert.

Wade C. Pendleton

See also **Africa** (picture: Botswana San); **Botswana; Religion** (picture: The San).

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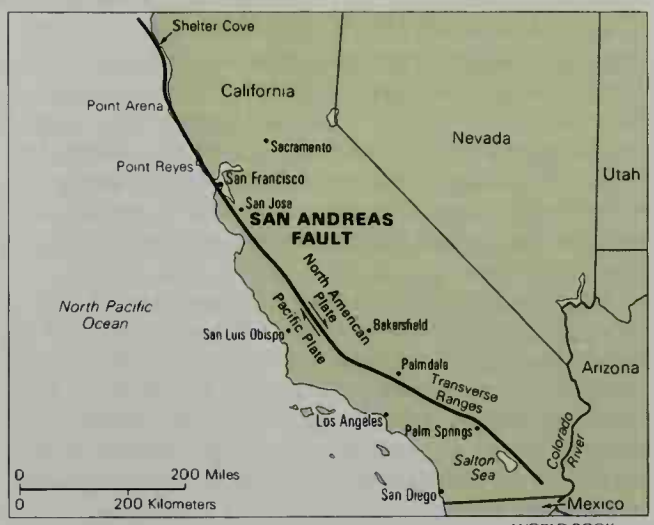
San Andreas Fault, *SAN an DRAY uhs,* is a long fracture in the earth's crust marked by a zone of disrupted land in California. The fault extends about 600 miles (970 kilometers) from off the coast of northwestern California to the southeastern part of the state.

According to the theory of *plate tectonics,* the earth's outer shell consists of a number of rigid plates that are in slow, continuous motion with respect to one another. During the past 15 million years, the San Andreas Fault has formed part of the boundary between the Pacific Plate and the North American Plate. During this time, coastal California, along with the rest of the Pacific Plate, has moved about 190 miles (300 kilometers) in a northwesterly direction with respect to North America. Today, movement along the San Andreas Fault averages 2 to 2 $\frac{1}{4}$ inches (5 to 6 centimeters) yearly. See **Earth** (diagram: The earth's plates).

The movement of the plates along the San Andreas Fault produces strain on the rocks near the plate boundary. Along some segments of the fault, the strain is released by frequent small earthquakes that do little damage. But along certain other segments of the fault, the plates are locked in place, and the strain builds up



WORLD BOOK map

The San Andreas Fault is a fracture in the earth's crust that extends through much of California. Sudden crustal movements along the fault have resulted in severe earthquakes.

Peter Menzel, Stock, Boston

A distinct surface fracture can be seen in this segment of the San Andreas Fault. The fracture extends along the Carrizo Plains, between San Luis Obispo and Bakersfield in California.

over many years. The built-up strain occasionally produces a major earthquake. In 1857, a sudden movement along a segment of the San Andreas Fault in the Transverse Ranges caused a severe earthquake in southern California. In 1906, movement along another fault segment resulted in a major earthquake in San Francisco. These two areas of the fault are locked and are likely to produce a major earthquake once every few hundred years. John G. Anderson

See also Earthquake; Plate tectonics.

San Antonio, Texas, is one of the most historic cities of the United States. During its history, San Antonio has been under the control of Spain, Mexico, and the independent Republic of Texas. It has been called *Alamo City,* in honor of the famous Battle of the Alamo that was fought there in 1836.

San Antonio ranks as one of the Southwest's leading cultural and trade centers. Some of the largest military bases in the United States are in the San Antonio area. The city lies on the rolling prairies of south-central Texas, about 150 miles (241 kilometers) northeast of the Mexican border.

San Antonio was officially founded in 1718 when the Spanish established the mission of San Antonio de Valero and a military post at the site. The mission was later called the Alamo. The Spanish government chose this location because it wanted a settlement midway between its missions in eastern Texas and its military posts in northern Mexico. Members of an earlier Spanish expedition had named the site *San Antonio* for Saint Anthony of Padua.

The city. San Antonio covers 328 square miles (850 square kilometers) in the center of Bexar County. Five independent communities lie within the city limits. They are Alamo Heights, Balcones Heights, Castle Hills, Olmos Park, and Terrell Hills. The San Antonio metropolitan area covers 3,354 square miles (8,687 square kilometers) and consists of all of Bexar, Comal, Guadalupe, and Wilson counties.

A bend in the San Antonio River encircles the heart of downtown San Antonio in the center of the city. River barges transport tourists through the downtown area. Shops, restaurants, and an open-air amphitheater line the riverbanks in an area called *Paseo del Rio* (River Walk). *La Villita* (Little Village) occupies a square block along the downtown riverfront. It includes restored houses and shops built by early Spanish settlers.

The Tower of the Americas rises 622 feet (190 meters) east of the river. Its observation decks offer a view of San Antonio and the surrounding countryside. The tower was originally built for HemisFair '68, a world's fair that celebrated the city's 250th anniversary. North of the tower stands the Henry B. Gonzalez Convention Center. The convention center includes a convention and exhibit hall, a 2,800-seat theater, and a 10,000-seat arena. To the east of the center stands the 72,000-seat Alamodome. The Alamo, the restored mission of San Antonio de Valero and site of the historic battle, stands in Alamo Plaza in downtown San Antonio. Other missions are located south of the city's downtown area.

Residential areas spread in all directions from downtown San Antonio. Suburbs of the city include Hollywood Park, Kirby, Universal City, and Windcrest.

People. About 92 percent of San Antonio's people were born in the United States. More than half are Hispanics, and much of the city's population speaks both English and Spanish. Other groups include people of English, French, German, Irish, Italian, or Polish ancestry. Blacks make up about 7 percent of the population.

Unlike many other large cities, San Antonio has had few racial disturbances. Government integration of the military bases after World War II ended in 1945 spread peacefully into the schools and other facilities.

Economy. Military, health care, and tourism activities contribute heavily to San Antonio's economy. Military bases in the San Antonio area employ about 44,000 military personnel and more than 35,000 civilians. San Antonio is the home of Fort Sam Houston, the headquarters of the U.S. Fifth Army. The U.S. Air Force operates three bases—Brooks, Lackland, and Randolph—in or near the city.

Medical and research facilities in San Antonio have made the city one of the Southwest's leading health care and science centers. The South Texas Medical Center contains 30 facilities, including hospitals, research centers, and the University of Texas Health Science Center. Brooke Army Medical Center at Fort Sam Houston and Wilford Hall Hospital at Lackland Air Force Base rank among the country's largest military medical facilities.

Facts in brief

Population: *City*—1,144,646. *Metropolitan area*—1,592,383.
Area: *City*—328 mi² (850 km²). *Metropolitan area*—3,354 mi² (8,687 km²).
Altitude: 701 ft (214 m) above sea level.
Climate: *Average temperature*—January, 52 °F (11 °C); July, 84 °F (29 °C). *Average annual precipitation* (rainfall and other forms of moisture)—28 in (71 cm).
Government: Council-manager. *Terms*—2 years for the 10 council members and the mayor; manager appointed.
Founded: 1718. Incorporated as a city in 1837.

Largest communities in the San Antonio area

Name	Population	Name	Population
San Antonio	1,144,646	Universal City	14,849
New Braunfels	36,494	Converse	11,508
Seguin	22,011	Leon Valley	9,239
Schertz	18,694	Live Oak	9,156
Canyon Lake*	16,870	Kirby	8,673

*Unincorporated.
Source: 2000 census.

Symbols of San Antonio. The red, white, and blue in the flag of San Antonio, *left,* represent the United States and Texas, which use these colors in their flags. The star on both the flag and the city seal, *right,* stands for Texas, the Lone Star State.

San Antonio is one of the biggest cities in Texas and a leading commercial and cultural center of the Southwest. Large office buildings and stores rise in the downtown area, *shown here.*

Bob Howen

The Southwest Research Center in San Antonio conducts research for government and industry.

San Antonio ranks as one of the leading convention cities in the Southwest. Conventions and tourism bring in nearly 11 million visitors a year.

Retail and wholesale trade activities and manufacturing are also important to San Antonio's economy. The city is the chief outlet for farm products from the surrounding agricultural region. Many of the city's manufactured products are exported to Mexico. About 1,300 manufacturing firms are in the San Antonio area. Their products include aircraft parts, clothing, electronic products, food products, fertilizer, medical supplies, oil field equipment, petroleum products, and other goods.

Three interstate highways link San Antonio with other parts of the country. About 30 truck lines and 3 railroad lines carry cargo to and from the city. The National Railroad Passenger Corporation (Amtrak) operates rail passenger service between San Antonio and other cities. The International Airport handles flights to and from most major U.S. cities and several cities in Mexico.

The city has two daily newspapers—the *San Antonio Express-News* and the *San Antonio Light.* Five television stations and about 25 radio stations serve the area.

Education. Sixteen independent public school districts, including three military districts, serve Bexar County. They operate about 200 elementary schools and about 100 junior and senior high schools. These schools have a total enrollment of approximately 225,000. About half the public school students are of Mexican or Spanish ancestry. Less than 10 percent of the students are black. San Antonio has about 60 private and church-supported schools, with a total enrollment of about 20,000 students.

The city's schools have a special problem because of the large Spanish-speaking population. Many Spanish-speaking students have difficulty understanding English, the language commonly used for instruction. As a result, many of them fail in school and, in time, drop out. To combat this problem, some schools in the city's Mexican-American areas conduct classes in both English and Spanish in the lower grades. The federal Head Start program also operates in Mexican-American areas to teach English to preschool children.

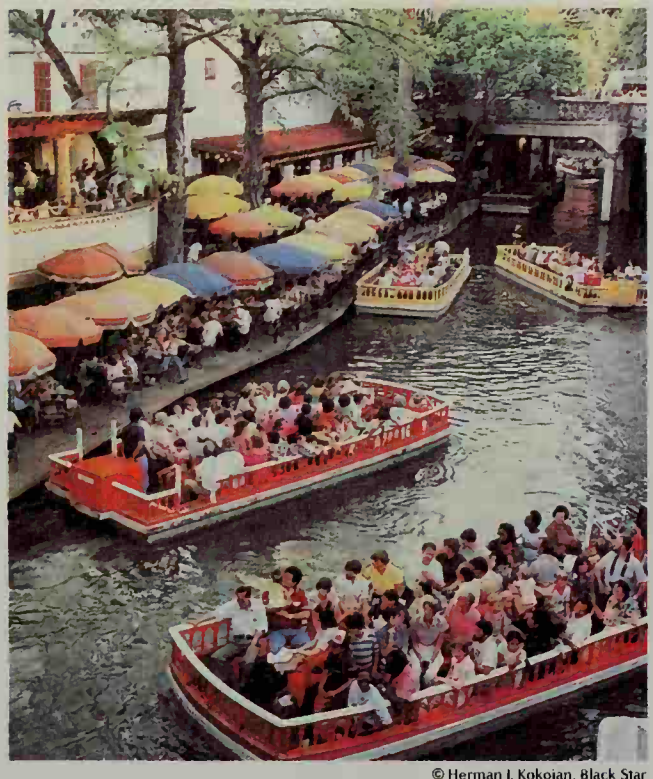
Universities and colleges in San Antonio include Our Lady of the Lake University, St. Mary's University, Trinity University, and University of the Incarnate Word. Two campuses of the University of Texas are located in the city—the University of Texas at San Antonio and the University of Texas Health Science Center. The city is also the home of a branch campus of the National Autonomous University of Mexico, the largest university in Mexico. Alamo Community College District operates three two-year colleges in San Antonio—Palo Alto College, St. Philip's College, and San Antonio College.

The San Antonio Public Library system consists of a main library and 14 branches. The library's Hertzberg Circus Collection includes a miniature circus and old circus posters.

Cultural life. The San Antonio Symphony performs at the Majestic Theatre. The Spring Festival, held in March, features stars of the Metropolitan Opera and a number of orchestras and dance groups. Theatergoers attend the San Pedro Playhouse and other community theaters.

The Marion Koogler McNay Art Institute displays American and European art works. The San Antonio Museum of Art features artworks by Texans and collections of American Indian, Mexican, and Spanish colonial art. The Witte Memorial Museum features exhibits on natural history and Texas culture. The Institute of Texas Cultures uses exhibits and films to describe the roles of various nationality groups in Texas history.

Much of San Antonio's cultural life reflects the city's Mexican and Spanish background. The government of Mexico sponsors a Mexican Cultural Exchange Institute in San Antonio to teach the customs and language of Mexico. The Alamo has been preserved as a museum. The city's other historic Spanish missions are Concepción, Espada, San Jose, and San Juan Capistrano. San Jose, called the "Queen of the Missions," is a national historic site. All the missions were built during the early 1700's.



© Herman J. Kokojan, Black Star

Paseo del Rio (River Walk), a lively dining and shopping center in downtown San Antonio, borders the San Antonio River.

Recreation. San Antonio has about 70 parks that cover a total of more than 4,300 acres (1,740 hectares). Brackenridge Park includes one of the nation's largest zoos, a sunken garden, and an outdoor theater. The city is the home of the San Antonio Spurs of the National Basketball Association.

The Fiesta San Antonio, held in April, celebrates the establishment of the Texas republic in 1836. This week-long festival features parades through the downtown area. The San Antonio Stock Show and Rodeo is held in February.

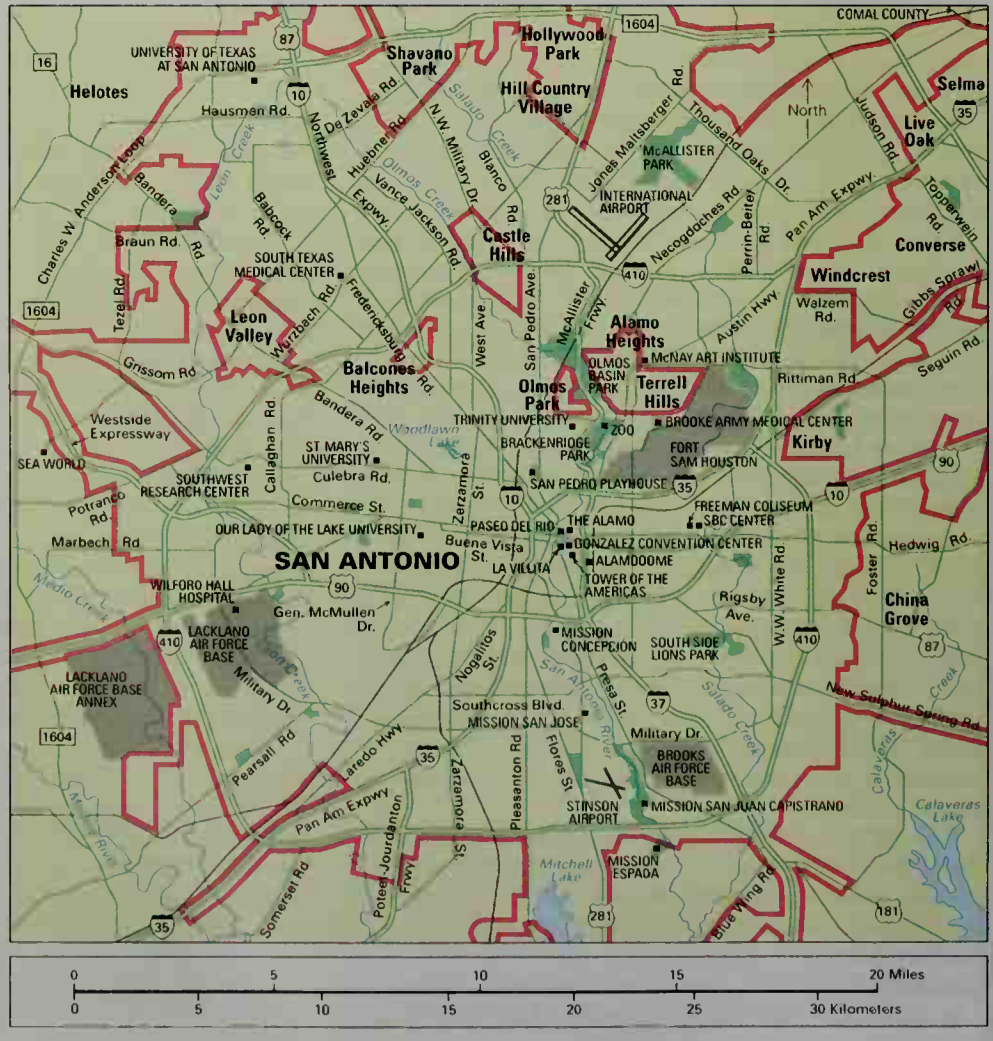
Government. San Antonio has a council-manager form of government. The voters elect a mayor and 10 council members to two-year terms. The mayor and council appoint a city manager to carry out their policies. Property and sales taxes and income from city-owned utilities provide most of San Antonio's revenue.

History. Coahuiltec Indians lived in what is now the San Antonio area long before white settlers first came. During the 1500's, Spanish explorers traveled through what is now Texas. France claimed the area from 1685 until 1690, when Spain sent an expedition to reestablish its earlier claims. The Spaniards reached the Indian village of Yanaguana on June 13, 1691, the feast day of Saint Anthony of Padua. They renamed the village and nearby river *San Antonio*.

Spain officially founded San Antonio in 1718. That year, Father Antonio Olivares established the mission of

San Antonio

San Antonio lies on the San Antonio River in south-central Texas. The city is an important industrial, trading, and military center. The map shows the city's major points of interest.



WORLD BOOK map

San Antonio de Valero on a branch of the San Antonio River. The Spaniards also established a military outpost, later named Fort San Antonio de Bexar, to protect the mission from Apache and Comanche Indians. The mission became known as the Alamo. It was later rebuilt at its present site. In 1731, the Spanish government sent 15 Spanish families from the Canary Islands to settle in the San Antonio region and build the community.

Mexico won independence from Spain in 1821, and San Antonio came under Mexican rule. Dissatisfaction with Mexican rule led the Texas settlers to revolt in 1835-1836. In one of the most famous battles in the struggle for Texas independence, 189 men defended the Alamo against about 4,000 Mexican soldiers. On March 6, 1836, after a 13-day siege, the Alamo fell to the Mexican forces. The Mexicans killed all the defenders. But on April 21, Texas forces defeated the Mexicans in the Battle of San Jacinto, and Texas became independent.

In 1837, San Antonio was incorporated as a city of the Republic of Texas. The city began to grow rapidly after 1845, when Texas became a state. In 1850, 3,488 people lived in San Antonio. Beginning in the 1860's, San Antonio thrived as a stop along cattle trails to Kansas. Businesses developed to trade in leather goods and supplies for cattle ranchers. San Antonio's first railroad came to the city in 1877. Between 1876 and 1879, the construction of what is now Fort Sam Houston established San Antonio as an important military center. By 1880, the city's population had reached 20,550.

In the late 1800's and early 1900's, discoveries of oil near San Antonio aided the city's growth. After the United States entered World War I in 1917, San Antonio served as a leading military training and supply center. This activity helped San Antonio's population jump from 96,614 in 1910 to 161,379 in 1920.

The city's growth rate slowed during the 1930's. But World War II (1939-1945) stimulated new growth, as San Antonio's military bases expanded. By 1950, the city had a population of 408,442. San Antonio more than doubled its area between 1950 and 1960 by annexing surrounding communities. These additions helped increase the city's population to 587,718 by 1960.

During the 1960's, urban renewal projects improved some of San Antonio's run-down areas. A new civic center was built and many historic buildings were restored. During the 1970's, the city built low- and moderate-cost housing for San Antonio's growing population. In 1981, voters elected Henry G. Cisneros mayor. Cisneros became the first Mexican-American mayor of a major U.S. city. He was reelected in 1983, 1985, and 1987. Cisneros served until 1989.

The 1990 U.S. census listed San Antonio as the nation's 10th largest city with a population of 935,933. By 2000, the city ranked 9th, and its population had grown to 1,144,626. Jay Rogers

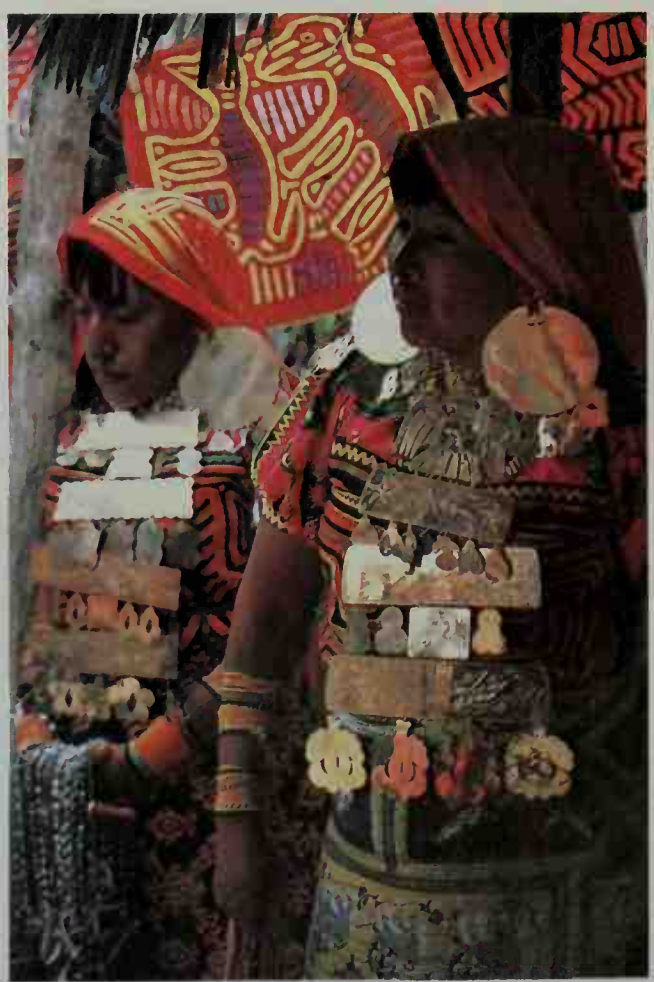
See also Alamo; Cisneros, Henry G.; Fort Sam Houston.

San Bernardino, *SAN buhr nuhr DEE noh* or *SAN buhr nuh DEE noh* (pop. 185,401), a city in southwestern California, is the seat of San Bernardino County. The county is one of the largest counties in area in the United States. It occupies more than 20,000 square miles (51,800 square kilometers). With adjoining Riverside County, San Bernardino County forms a trading center called the Inland Empire. These two counties make up the Riverside-San Bernardino metropolitan area (pop. 3,254,821). All or part of seven U.S. military bases are in San Bernardino County. For location of the city and the county, see **California** (political map).

The city of San Bernardino lies at the foot of the San Bernardino Mountains. Nearby San Gorgonio Mountain, which rises 11,499 feet (3,505 meters), is the highest place in southern California. Spanish settlers founded San Bernardino in 1810. The city was incorporated in 1854. It was once California's center for citrus growing. Today, the area's chief agricultural products are cattle, eggs, and milk. Wholesale trade and manufacturing are the largest private industries. The city is the home of California State University at San Bernardino. San Bernardino has a mayor-council government. James J. Rawls

San Blas Indians, *san BLAS,* is the term for four tribes of Indians that live on the San Blas Islands off the eastern coast of Panama. Most of the 20,000 Indians belong to the Cuna tribe. These Indians live now much as they did before Europeans came to Latin America. Tribal law prohibits marriage with whites. The highest proportion of albino births in the world occurs among the San Blas (see **Albino**). Experts estimate that about 7 out of 1,000 San Blas are albinos. The albinos gave rise to the myth that a tribe of "white Indians" lived in Panama.

Samuel M. Wilson



Erwin A. Bauer

Cuna Indian women of the San Blas Islands wear traditional dress, including large necklaces and disk-shaped earrings.

WORLD BOOK photo by David R. Frazier

Downtown San Diego lies on San Diego Bay, one of the world's finest natural harbors. The city is a popular tourist destination, as well as an important hub of operations of the United States Navy.

San Diego

San Diego, California, is the seventh largest city in the United States and an important base of operations for the U.S. Navy. The city lies in the southwestern corner of the country and is bordered by the Pacific Ocean on the west and by Mexico on the south.

San Diego has experienced dramatic growth since the mid-1900's. In 1940, it ranked 43rd in population among U.S. cities. But by 2000, it had jumped to 7th. Among the cities in California and on the Pacific Coast, only Los Angeles is larger.

San Diego has one of the finest natural deepwater harbors in the world. The harbor, which is on San Diego Bay, serves oceangoing ships and United States Navy vessels. The city is a major tourist center. The San Diego Zoo and Sea World each attract millions of visitors every year. San Diego has a thriving arts community, with numerous museums and theaters.

The city is sometimes called *The Birthplace of California.* It was founded in 1769, when Spanish soldiers built California's first *presidio* (military fort) on the site. The Spaniards chose the location because of the fine harbor. That same year, a Franciscan priest, Junípero Serra, established California's first mission within the presidio.

The city

Layout of San Diego. San Diego covers 324 square miles (839 square kilometers). It is the seat of San Diego County. The city's southern boundary forms part of the border between the United States and Mexico. Los Angeles lies about 125 miles (200 kilometers) to the north.

Downtown San Diego extends inland from San Diego Bay to Balboa Park—the site of the famed San Diego Zoo. The Community Concourse, a modern civic center, lies in the heart of the busy downtown area. It includes the City Administration Building as well as the Civic Theatre, the city's largest theater. The San Diego Convention Center has a nautical design in keeping with its location on the harbor's edge. Horton Plaza, named for downtown developer Alonzo E. Horton, is a multilevel shopping and dining complex. The 16-block Gaslamp Quarter, also downtown, has been restored to its appearance during the late 1800's.

San Diego's original downtown was established a few miles northwest of the present downtown. This area is known as Old Town. A number of historic buildings that made up the original downtown have been restored or reconstructed. They surround a plaza at Mason Street and San Diego Avenue. Just northeast of Old Town is Presidio Park, the site of the original presidio.

Point Loma, a peninsula that forms part of the entrance to San Diego Bay, is a popular tourist destination. It includes the Old Point Loma Lighthouse and the Cabrillo National Monument. First lit in 1855, Old Point Loma is one of the oldest lighthouses on the Pacific Coast. It honors Juan Rodríguez Cabrillo, a Portuguese explorer who sailed into San Diego Bay in 1542.

The geography of the San Diego area includes numerous canyons and mesas. Some neighborhoods were built in the canyons, and others overlook them. In some areas, canyons separate neighborhoods.

Many of San Diego's most fashionable neighborhoods and resort areas overlook the Pacific Ocean. Such areas within the city include La Jolla (pronounced *luh HOY uh*), Mission Beach, and Pacific Beach.

San Diego's mild, sunny climate helps make the city a popular vacation spot. Temperatures average 69 °F (21 °C) in summer and 56 °F (13 °C) in winter. Precipitation totals only about 10 inches (25 centimeters) yearly.

The metropolitan area of San Diego extends over the entire county. It covers 4,205 square miles (10,891 square kilometers) and includes 17 incorporated cities and towns besides San Diego. One of the best-known suburbs is the resort town of Coronado, on a peninsula in San Diego Bay. The San Diego-Coronado Bay Bridge, which is about 2 $\frac{1}{4}$ miles (3.5 kilometers) long, connects Coronado to downtown San Diego. Other suburban San Diego communities include Carlsbad, Chula Vista, Del Mar, El Cajon, Escondido, Imperial Beach, La Mesa, National City, Oceanside, Santee, and Vista.

San Diego's suburbs also offer numerous points of interest. Perhaps the most famous is San Diego Wild Animal Park, a wildlife preserve in Escondido. Also in Escondido, San Pasqual Battlefield State Historic Park commemorates the 1846 Battle of San Pasqual. This was the most significant battle fought in California during the Mexican-American War. Visitors to Chula Vista can tour the Chula Vista Nature Center, one of the few remaining salt marsh habitats on the Pacific Coast. The marsh is regularly flooded by seawater at high tide. A famous site in Oceanside is Mission San Luis Rey de Francia. Established in 1798, it was once the largest and most prosperous of the California missions.

People

Ethnic groups. San Diego has wide cultural diversity. About 20 percent of the city's residents were born out-

City of San Diego

San Diego is a naval and aerospace center. The large map shows major landmarks in and around the city. The small map shows the Pacific coast from Los Angeles to Mexico.

City boundary
County boundary
International boundary
Expressway
Road or street
Railroad
Airport
Point of interest
Park
Military area

WORLD BOOK maps

Facts in brief

Population: *City*—1,223,400. *Metropolitan area*—2,813,833.
Area: *City*—324 mi² (839 km²), including 15 mi² (40 km²) of inland water. *Metropolitan area*—4,205 mi² (10,891 km²).
Climate: *Average temperature*—January, 56 °F (13 °C); July, 69 °F (21 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—10 in (25 cm).
Government: Council-manager. *Terms*—4 years for the mayor and 8 other council members; manager appointed.
Founded: 1769. Incorporated as a city in 1850.

Largest communities in the San Diego area

Name	Population	Name	Population
San Diego	1,223,400	Vista	89,857
Chula Vista	173,556	Carlsbad	78,247
Oceanside	161,029	Encinitas	58,014
Escondido	133,559	San Marcos	54,977
El Cajon	94,869	La Mesa	54,749

Source. 2000 census.

Symbols of San Diego. The flag includes the city seal and the date 1542, when the explorer Juan Rodríguez Cabrillo sailed into San Diego Bay. The bell tower on the middle of the seal symbolizes the influence of missionaries on the city's early development.

side the United States, and 30 percent speak a language other than English at home. Non-Hispanic whites make up about 50 percent of the city's population. Hispanics, who may be white, black, or of mixed ancestry, make up about 25 percent. The majority of Hispanics in San Diego are of Mexican heritage. African Americans account for about 8 percent. Together, Asians and Pacific Islanders also make up about 14 percent of the population. San Diego County includes 18 American Indian reservations, representing several Indian nations. Some American Indians reside in the city.

Housing. Housing costs in San Diego rank among the highest in the United States. The region's dwellings include elegant Craftsman-style houses built in the 1920's and 1930's. These houses feature intricately carved cabinets and woodwork. Some older neighborhoods have many ornate, Victorian-style homes. After World War II ended in 1945, a housing boom introduced numerous, more affordable two- and three-bedroom bungalows. Spanish influences, such as *stucco* (rough plaster) walls and red tile roofs, appear on both older and newer houses.

San Diego has several military facilities. The thousands of military personnel stationed there contribute to a shortage of good low-cost housing. The city also faces the problem of providing shelter for its large group of homeless people.

Education. The city of San Diego operates about 155 public schools that serve about 130,000 students. The rest of San Diego County has about 430 public schools with approximately 380,000 students. Many church-supported and other private schools also operate in the county.

San Diego has a number of colleges and universities. The University of California at San Diego, in La Jolla, is part of the University of California system. The city's famous Scripps Institution of Oceanography is part of the university. San Diego State University is part of the California State University system. Other colleges and universities in the area include the University of San Diego, National University, Point Loma Nazarene College, and Alliant International University.

Social problems. Like many large cities, San Diego faces the problems of poverty and homelessness. Numerous public and private organizations work to provide shelter and social services. San Diego County maintains two schools for homeless children. Both of the schools are downtown, where the homeless population is largest.

The city's location close to the Mexican border creates both benefits and problems. Mexican residents and tourists who cross the border from Mexico into San Diego County frequently shop in the San Diego area, spending more than $2.5 billion a year. However, some Mexicans come to the United States to work without immigration papers that they need to hold jobs legally. Operation Gatekeeper, a United States Border Patrol program, was introduced in 1994 to make illegal entry into the United States more difficult. The program calls for more patrols, improved fences, and other measures to guard the border against illegal immigration.

Cultural life

The arts. The San Diego Symphony Orchestra plays at Symphony Hall. The Civic Theatre downtown is the home of the San Diego Opera. Major theater performances in San Diego are staged at the La Jolla Playhouse and the Old Globe Theatre in Balboa Park. Both theaters have sent successful plays to Broadway. The Old Globe, part of the Simon Edison Center for the Performing Arts, produces plays by the great English dramatist William Shakespeare each summer.

Suburban performing arts centers include the Poway Center for the Performing Arts in Poway and the California Center for the Arts in Escondido. Both are in northern San Diego County.

Museums and libraries. San Diego has a wide variety of interesting museums, many in Balboa Park. Among the museums in the park are the San Diego Museum of Art, which features paintings by European masters; and the Timken Museum of Art, which owns a valuable collection of Russian religious art. Also in the park, the Museum of Photographic Arts houses contemporary and historic photo exhibits. The Centro Cultural de la Raza features Mexican, Mexican American, and American Indian visual and performing arts; and the Reuben H. Fleet Space Theater and Science Center offers science exhibits, a planetarium, and a large-format motion-picture theater. Both are in Balboa Park as well.

WORLD BOOK photo by David R. Frazier

Balboa Park includes a wide variety of interesting museums, scenic gardens, and the famous San Diego Zoo. Several buildings in the park, including the Botanical Building, *shown here,* were constructed to house the Panama-California Exposition, an international fair. San Diego hosted the exposition in 1915 and 1916.

Along the wharf, the Maritime Museum features the *Star of India,* an iron sailing ship built in the 1860's. In Presidio Park, the Junípero Serra Museum has exhibits on early San Diego history. The Museum of Contemporary Art in La Jolla displays modern painting, sculpture, and photography. A branch of the museum is in downtown San Diego. Also in La Jolla, the Stephen Birch Aquarium-Museum displays marine life from around the world in more than 30 aquariums.

The San Diego public library system consists of the Central Library downtown and branches throughout the city. The San Diego County library system allows suburban libraries throughout the county to share books and other materials with one another.

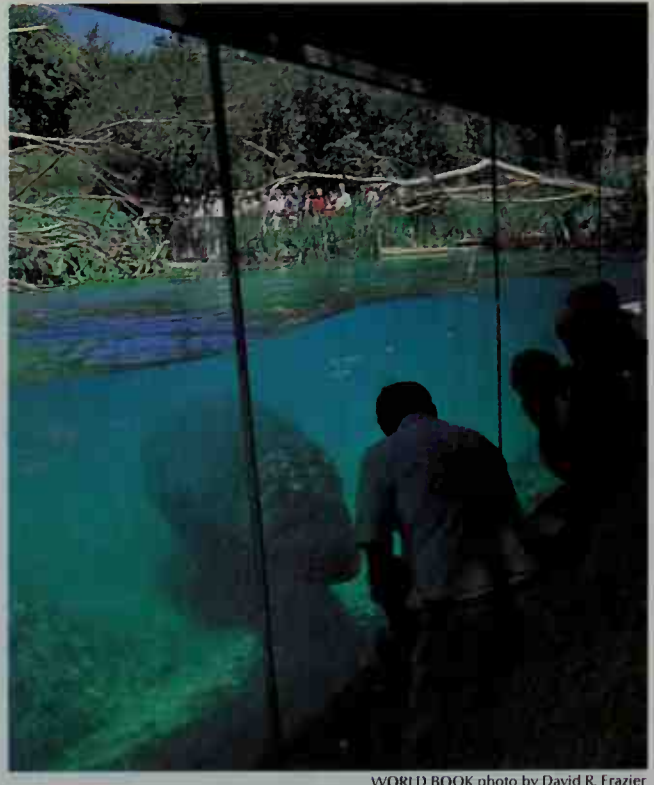
Recreation. San Diego's mild climate allows residents to enjoy an outdoor lifestyle all year long. San Diego County has 70 miles (112 kilometers) of ocean beaches. The city of San Diego has about 175 parks. Mission Bay Park, one of the largest parks, covers more than 4,600 acres (1,850 hectares). It includes an aquatic park with areas for fishing, swimming, and boating. The park is also home to Sea World, a 150-acre (60-hectare) marine park featuring dolphins, sharks, penguins, and killer whales. The restored Giant Dipper roller coaster is in nearby Belmont Park. It was built in 1925.

The famous San Diego Zoo is in Balboa Park. It is known for its work in preserving endangered species of animals. It houses about 4,000 animals of about 900 species in a 100-acre (40-hectare) garden of tropical plants and flowers. The zoo also operates the popular San Diego Wild Animal Park in Escondido, which features a guided 5-mile (8-kilometer) monorail "safari."

The city is the home of the San Diego Padres of baseball's National League. It is also the home of the National Football League's San Diego Chargers.

The Mexican city of Tijuana lies about 15 miles (25 kilometers) south of downtown San Diego. It is a favorite destination of visitors to the area. Tijuana's attractions include gift shops, restaurants, nightclubs, bullfights, and horse races.

The Palomar Observatory, which houses the huge Hale Telescope, has a visitor's gallery and offers guided tours. The observatory stands on Palomar Mountain, about 45 miles (70 kilometers) northeast of downtown San Diego. Also northeast lies the Anza-Borrego Desert State Park, which has hiking and driving trails through 600,000 acres (240,000 hectares) of California desert. A spectacular array of wildflowers bloom there in March and April.



WORLD BOOK photo by David R. Frazier

San Diego Zoo is one of the city's most popular attractions. Windows at the zoo's modern hippopotamus display enable visitors to view the animals below the surface of the water.

Economy

Manufacturing ranks as the San Diego area's largest industry in terms of revenue. However, the industry employs only about 10 percent of the county's workers. The area's major manufacturers build ships and make medical instruments and electronic and oceanographic equipment.

The armed forces and other government agencies make up San Diego's second largest industry. About one-fifth of San Diego residents are employed by the government. Many residents work at the huge San Diego Naval Base.

Tourism is San Diego's third largest revenue-producing industry. San Diego attracts millions of visitors a year. Spending by visitors contributes heavily to the economy. Tourism generates many jobs related to dining, lodging, shopping, and recreation.

Several major health and medical research firms are based in the San Diego area. The area ranks among the largest centers for biotechnology in the United States. About 100 companies in this field apply technology to solve problems in biology and medicine. More than 55,000 small businesses operate in the metropolitan area, most employing fewer than 100 people.

San Diego County ranks among the top 25 counties in the United States in the market value of its agricultural production. It is one of the world's leading avocado growing areas.

Transportation and communication. Major airlines operate out of San Diego International Airport. Passenger railroads and several steamship lines serve the city as well. San Diego Transit buses serve the city. The San Diego Trolley system carries about 15 million passengers a year between southern and eastern parts of the county and downtown San Diego.

San Diego has one daily newspaper, the *San Diego Union-Tribune*. About 40 radio stations, 7 regular television stations, and several cable TV systems serve the metropolitan area. The *San Diego Daily Transcript* publishes news of interest to the local business community.

Government

San Diego has a council-manager form of government. Voters elect a mayor and eight other City Council members to four-year terms. The council appoints a city manager, who serves as administrative head of the government. Property and sales taxes are the chief source of San Diego's income.

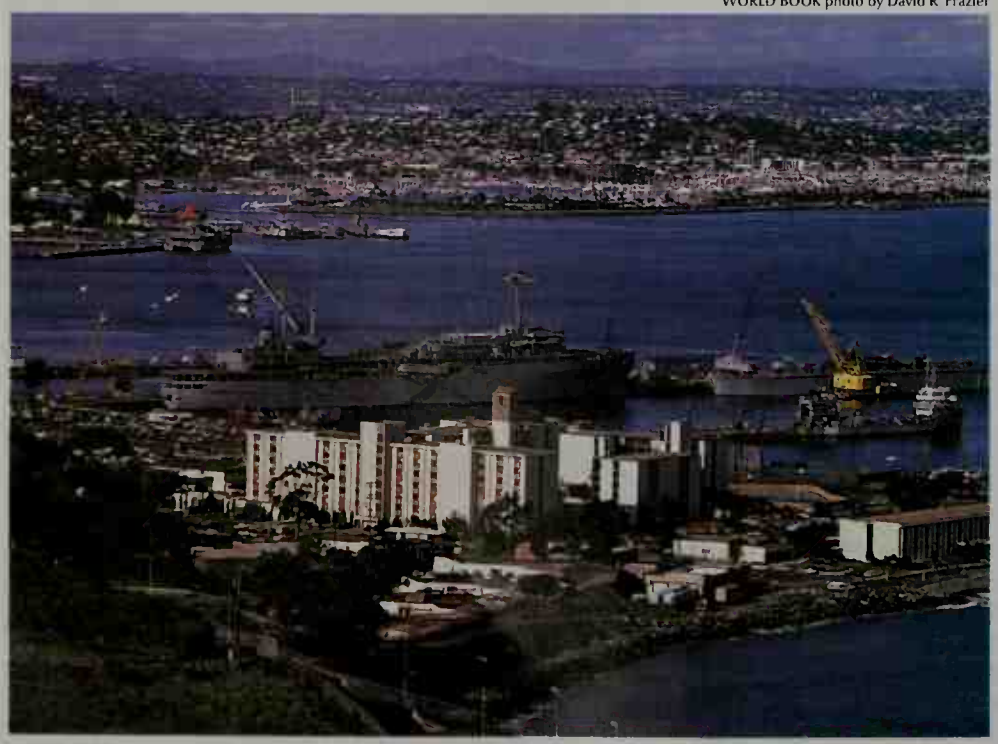
San Diego County is governed by a five-member Board of Supervisors. Board members are elected to four-year terms. The Board of Supervisors appoints a chief administrative officer to handle the day-to-day affairs of government.

History

Early years. Indians lived in what is now the San Diego area long before Europeans arrived. The Spaniards called the Indians the Diegueño. Juan Rodríguez Cabrillo was probably the first European to enter the region. Cabrillo, a Portuguese explorer in the service of Spain, sailed into what is now San Diego Bay in 1542. An expedition led by the Spanish explorer Sebastián Vizcaíno reached the area on Nov. 10, 1602. Vizcaíno's flagship was called the *San Diego* (Spanish for Saint Didacus). On November 12, the feast day of San Diego de Alcalá, a Spanish saint, priests with the expedition said Mass. The bay was named San Diego, probably to honor the flagship and the feast day.

No white settlers came into the area until 1769. That year, Spanish soldiers from Mexico constructed a presidio on a hill near San Diego Bay. Junípero Serra, a Franciscan priest, established California's first mission within the presidio that same year. The mission, the presidio, and—later—the city were also given the name San Diego. Mission San Diego de Alcalá was the first of 21

WORLD BOOK photo by David R. Frazier



San Diego Bay plays an important role in the regional economy of San Diego. The bay serves U.S. Navy ships, ocean liners, and fishing and sightseeing boats, as well as recreational vessels. The huge San Diego Naval Base employs thousands of area residents.

missions established in California. Serra established eight more missions in California before he died in 1784.

In 1774, the mission was rebuilt about 5 miles (8 kilometers) up the valley, closer to an Indian village. The new location also had a better water supply for crops. During the early 1800's, colonists began settling at the bottom of the hill on which the presidio stood. This is the area now known as Old Town.

The trading of cattle hides became an important activity in the area during the early 1800's. San Diego's port helped make the settlement a center of the Pacific Coast hide trade. Located close to a migration route for gray whales, the port also was a base for whaling ships from the 1850's to the 1870's.

San Diego was organized as a town in 1834. It adopted a city charter in 1850, the same year that California became a state. By 1860, San Diego had a population of 731. A businessman named Alonzo E. Horton purchased land along eastern San Diego Bay in 1867. He laid out an area called New Town, which soon became the new center of the town.

Growth. The California Southern Railroad provided the first rail link to San Diego from the eastern United States in 1885. Its arrival created a land boom. Business expanded rapidly. By 1887, the city's population had jumped to about 40,000. But the boom ended suddenly, and by 1890 the population of San Diego had fallen to about 16,000.

During the early 1900's, a growing demand for tuna led to the establishment of large fish canneries in San Diego. Several companies built their canneries there because of the city's port facilities and location close to tuna-fishing waters.

In 1915 and 1916, San Diego hosted the Panama-California Exposition, an international fair. The event brought worldwide attention to the city and made Balboa Park a popular tourist attraction.

Military center. San Diego's rapid development as a major naval center occurred largely because of World War I (1914-1918). The San Diego Naval Base and North Island Naval Air Station both opened in 1917, the year the United States entered the war. By 1920, 75,000 people lived in the city. San Diego became the headquarters of the 11th Naval District in 1922.

Consolidated Aircraft Corporation (now called General Dynamics), a major aircraft and defense manufacturer, moved to San Diego in 1935. Other contractors and related companies soon followed. By 1940, San Diego's population had passed 200,000.

In the 1940's, the armed forces and defense contractors became the dominant forces in San Diego's economy. After the United States entered World War II in 1941, San Diego's airplane plants attracted thousands of workers from throughout the country. The armed services also built new military facilities in the city. Thousands of people received military training in San Diego before serving overseas. Many of these people returned to live in the San Diego area after the war ended in 1945. They enjoyed the area's mild climate and numerous outdoor recreation opportunities. By 1950, the population of San Diego had risen to more than 330,000.

Economic changes brought more diversity to San Diego's economy during the second half of the 1900's. Competition from Japanese and South American tuna canneries and a decline in the aircraft industry damaged the city's economic base in the 1950's. But gains in missile production and shipbuilding helped make up the loss.

Large-scale unemployment followed a further decline in the aircraft and spacecraft manufacturing industry in the early 1960's. Civic leaders established programs to broaden San Diego's economic base. Development of several new industrial parks for factories and warehouses helped attract many new industries. In the 1970's, San Diego grew as a center of health science and medical research activities.

The decline of Cold War tensions in the late 1980's and an economic recession in the early 1990's led to a further decline in the role of defense in San Diego's economy. In 1994, the Martin Marietta Corporation, a major defense contractor, left San Diego, eliminating many jobs. In 1996, General Dynamics Corporation, the region's largest civilian employer, closed its San Diego-based Convair division. In 1997, cuts in the federal defense budget resulted in the closing of the San Diego Naval Training Center at the San Diego Naval Base. However, the emergence of new high-technology companies in San Diego helped reduce the economic impact.

Other recent developments. San Diego completed several major development projects in the 1980's and 1990's, including Horton Plaza and the San Diego Convention Center. The city also experienced another dramatic increase in population during this period. By 2000, the city's population had climbed to about 1,200,000, and the metropolitan area had over 2 $\frac{3}{4}$ million people.

Karen Lin Clark

Related articles in *World Book* include:
California (pictures)
Hispanic Americans (picture)
Palomar Observatory
San Diego Marine Corps Recruit Depot
San Diego Naval Base
Scripps Institution of Oceanography
Serra, Junípero
Tijuana
Zoo (picture)

San Diego Marine Corps Recruit Depot, California, trains United States Marine Corps recruits generally from west of the Mississippi River. It covers about 500 acres (200 hectares) and lies 3 miles (5 kilometers) north of downtown San Diego. The depot includes a recruit training command and schools. It was commissioned as a Marine Corps base in 1921.

Critically reviewed by the United States Marine Corps

San Diego Naval Base, California, provides headquarters for several United States Pacific Fleet commands. These commands include the naval air force, cruiser-destroyer, amphibious force, and training commands, and the Third Fleet. The base also includes the 11th Naval District Headquarters, a hospital, a naval station, a supply center, a recruit depot, and naval air stations on North Island and Miramar. There is also an antisubmarine warfare school and an antiair warfare training center. An amphibious base is at Coronado, on San Diego Bay.

San Diego Naval Base covers about 171,000 acres (69,000 hectares), the largest U.S. naval base in area. Naval activity began there in 1917. The full name of the base is Commander Naval Base San Diego. W. W. Reid

San Domingo, a variant of Santo Domingo. See **Santo Domingo.**

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Scenic San Francisco is nearly surrounded by water. The San Francisco-Oakland Bay Bridge, *foreground,* which crosses San Francisco Bay, links the city to nearby communities.

San Francisco

San Francisco is one of the largest cities in California and a leading center of culture, finance, and industry in the United States. It is also one of the world's most attractive cities. Its clanging cable cars, fascinating Chinatown, and many hills give the city a special charm. Its scenic beauty and mild climate make it a popular tourist destination.

With more than 775,000 people, San Francisco is one of the largest cities on the Pacific Coast of the United States. It also has one of the largest Asian American populations on the mainland of the United States. About 240,000 people of Chinese, Japanese, Philippine, Korean, Thai, and Vietnamese ancestry live in the city.

San Francisco is built on and around more than 40 hills. Some of the steepest streets in the world lie in San Francisco's downtown area on Nob Hill and Russian Hill. These hills rise as high as 376 feet (115 meters). Cable cars and other vehicles seem almost to stand on end as they climb or descend the slopes.

San Francisco lies on the northern tip of a peninsula. The sparkling blue water that nearly surrounds the city provides a magnificent setting. The Pacific Ocean lies to the west and San Francisco Bay to the east. On the north, a strait 1 mile (1.6 kilometers) wide connects the Pacific Ocean and San Francisco Bay. This strait is named the Golden Gate, and San Francisco is often called the *City by the Golden Gate.* It is also known as the *City by the Bay.*

Indian cultures flourished in the San Francisco region for countless generations before Spanish settlers arrived in 1776. Gold was discovered east of San Francisco in 1848, and the city quickly became a busy mining supply center during the gold rush of 1849. In the late 1800's, the city thrived as the financial and industrial capital of the western United States. Then, in 1906, a terrible earthquake and fire destroyed most of San Francisco. But the residents soon rebuilt their city. In 1945, the United Nations (UN) was organized in San Francisco.

The city

San Francisco covers 129 square miles (334 square kilometers), including 83 square miles (215 square kilometers) of water, and occupies all of San Francisco County. San Francisco includes several islands in the Pacific Ocean and in San Francisco Bay. Alcatraz, the most famous island, lies in the bay. It was the site of a famous federal prison for dangerous criminals from 1934 to 1963. Today, the prison is a tourist attraction.

Many people consider San Francisco's climate to be ideal. The temperature rarely rises to 80 °F (27 °C) or drops to 30 °F (−1 °C). However, fog often covers the western part of the city. It forms when warm air flows over the cold ocean water.

Downtown San Francisco lies in the northeastern part of the city. Market Street is the main downtown street. It has large department stores and many fashionable shops. Union Square is the main shopping area. The Civic Center stands at Van Ness Avenue and McAllister Street, just north of Market Street. The center includes City Hall, the Asian Art Museum, the War Memorial Opera House, and Davies Symphony Hall.

Nob Hill rises northeast of the Civic Center. Two large luxury hotels, the Fairmont and the Mark Hopkins, have been built on this hill. The business district of Chinatown lies east of Nob Hill. Thousands of people of Asian ancestry live in the crowded Chinatown area. The area includes one of the largest Chinese communities outside Asia. Colorful shops, restaurants, and other buildings with Chinese-style upturned roofs stretch for eight blocks along Chinatown's lively Grant Avenue.

San Francisco's busy financial district is just east of Chinatown and centers on Montgomery Street. Many banks, investment houses, and other financial firms are on this street. It has been nicknamed the *Wall Street of the West,* after New York City's great financial district. The Transamerica Pyramid, perhaps San Francisco's most striking building, stands on Montgomery Street. This sleek, white office building towers 853 feet (260 meters) and looks like a thin pyramid. The impressive 52-story Bank of America building rises nearby. It is the home of one of the world's largest commercial banks.

Farther east, a modern residential and commercial complex called the Golden Gateway Center covers 51 acres (21 hectares) near the shore of San Francisco Bay. The center includes tall, elegant apartment and office buildings, shops, parks, and tiled plazas.

The Port of San Francisco borders the bay, which is one of the largest natural harbors in the world. The bay covers about 450 square miles (1,170 square kilometers). A wide street called the Embarcadero parallels the shore. At the middle of the port, across the Embarcadero from the Golden Gateway Center, stands the Ferry Building with its famous clock tower. The building once was a terminal for ferryboats that carried passengers between San Francisco and the eastern shore of the bay. Today, it houses the World Trade Center, which has offices for firms that deal in international trade.

Russian Hill rises in the northern part of downtown San Francisco. It includes what is called the *Crookedest Street in the World.* This street, a section of Lombard Street, makes eight sharp turns in a single block. The white Coit Tower, a famous San Francisco landmark, stands on top of nearby Telegraph Hill. The 210-foot (64-meter) tower is a memorial to the city's firefighters.

At the northern end of the Embarcadero lies Fisherman's Wharf, once the home of a huge fleet of colorful fishing boats. Today, the wharf is known chiefly for its many seafood restaurants. Nearby are two unusual shopping centers—the Cannery and Ghirardelli Square. The Cannery was once a food-processing factory, and Ghirardelli Square was a chocolate factory. They now house a variety of shops. North of Ghirardelli Square is San Francisco Maritime National Historical Park. The park includes a maritime museum and several restored ships of the 1800's docked at a pier.

Residential districts. North Beach, in northeastern San Francisco, is one of the city's oldest residential neighborhoods. It occupies the western slope of Telegraph Hill. Italian immigrants settled the area in the mid-1800's. Other neighborhoods that developed during this period include Potrero Hill and the Mission District. Potrero Hill lies south of the downtown area, and the Mission District lies southwest of downtown. The historic Mission Dolores stands in the Mission District. The original mission, founded by the Spanish in 1776, was

San Francisco facts in brief

Population: *City*—776,733. *Metropolitan area*—1,731,183. *Consolidated metropolitan area*—7,039,362.
Area: *City*—129 mi² (334 km²), including 83 mi² (215 km²) of water. *Metropolitan area*—1,269 mi² (3,287 km²). *Consolidated metropolitan area*—7,960 mi² (20,616 km²).
Climate: *Average temperature*—January, 50 °F (10 °C); July, 59 °F (15 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—22 in (56 cm). For the monthly weather in San Francisco, see California (Climate).
Government: Mayor-council (for city and county combined). *Terms*—4 years for the mayor and the 11 members of the council, called the Board of Supervisors.
Founded: 1776. Incorporated as a city in 1850.

Largest communities in the San Francisco area

Name	Population	Name	Population
San Francisco	776,733	San Rafael	56,063
Daly City	103,621	Novato	47,630
San Mateo	92,482	San Bruno	40,165
Redwood City	75,402	Pacifica	38,390
South San Francisco	60,552	Menlo Park	30,785

Source: 2000 census.

Symbols of San Francisco. The city flag was adopted in 1940 and the seal in 1914. Both symbols show the city motto, *Gold in Peace—Iron in War,* in Spanish. Both also have a phoenix, a mythical bird that rose from its own ashes, representing the city's rebirth after the 1906 earthquake and fire.

WORLD BOOK map

San Francisco lies on the Pacific Coast in California.

destroyed by fire. It was replaced by another mission, which dates from 1782 and still stands.

The Western Addition, a neighborhood just west of the downtown area, is noted for its nearly 100-year-old houses built in the elaborate Victorian style. Many of these homes have been restored. The Western Addition is also the site of the Japanese Trade and Cultural Center. This huge complex, which includes shops, restaurants, motion-picture theaters, and a hotel, is the center of an area called Japantown.

The Presidio, originally a Spanish army post, covers about 1,500 acres (607 hectares) in northwestern San Francisco. Until 1995, it served as the headquarters of the U.S. Sixth Army. In 1996, President Bill Clinton signed legislation that called for transforming the Presidio into a national park within 15 years. The officers' club, built in 1776, is the city's oldest building.

Almost all the residential areas in western San Francisco began to develop in the early 1900's. Sea Cliff, a community known for its large, well-landscaped homes, lies west of the Presidio along the Golden Gate. Nearby is Lincoln Park. The park includes the California Palace of the Legion of Honor, one of the city's finest museums. Farther south, Golden Gate Park extends from the Pacific Ocean to the center of the city. It covers 1,017 acres (412 hectares) and is one of the nation's largest city parks. The park's attractions include the California Academy of Sciences, Strybing Arboretum and Botanical Gardens, and a Japanese tea garden.

Overlooking the eastern end of Golden Gate Park is Mount Sutro, which rises more than 900 feet (270 meters). Nearby, Mount Davidson and two hills called Twin Peaks reach about the same height. Many expensive homes have been built on the slopes of all these hills.

Most of San Francisco's newest neighborhoods lie in the southwestern part of the city. This area also includes San Francisco State University and Lake Merced, a large freshwater lake.

The metropolitan area of San Francisco covers 1,269 square miles (3,287 square kilometers). It extends over three counties—Marin, San Francisco, and San Mateo. About 1 $\frac{3}{4}$ million people live in this area. San Francisco forms part of the San Francisco-Oakland-San Jose Consolidated Metropolitan Area. About 7 million people live in this larger metropolitan area.

Two spectacular bridges link San Francisco to other parts of the Bay Area. The 8 $\frac{1}{4}$-mile (13.3-kilometer) San Francisco-Oakland Bay Bridge crosses the bay. The Golden Gate Bridge connects the city and its northern suburbs. Its main section stretches 4,200 feet (1,280 meters) and is one of the world's longest spans.

WORLD BOOK map

People

Population. Whites make up 50 percent of San Francisco's population. Asian Americans make up 31 percent. Hispanics, who may be of any race, account for about 14 percent, and African Americans make up about 8 percent.

The largest ethnic groups among whites are people of English, German, Irish, Italian, and Russian ancestry. Chinese make up the largest group of Asian Americans. Many of the first Chinese came to work in the mines during the gold rush of 1849. Thousands of others arrived in the 1860's to help build the Central Pacific Railroad, which formed part of the first transcontinental railroad system in the United States. Other large groups of Asian Americans in San Francisco consist of people who are of Japanese, Philippine, or Vietnamese descent. Mexican Americans make up the city's largest group of Hispanics. San Francisco's black population began to increase during World War II (1939-1945). At that time, thousands of African Americans came from the South to seek jobs in the booming shipyards.

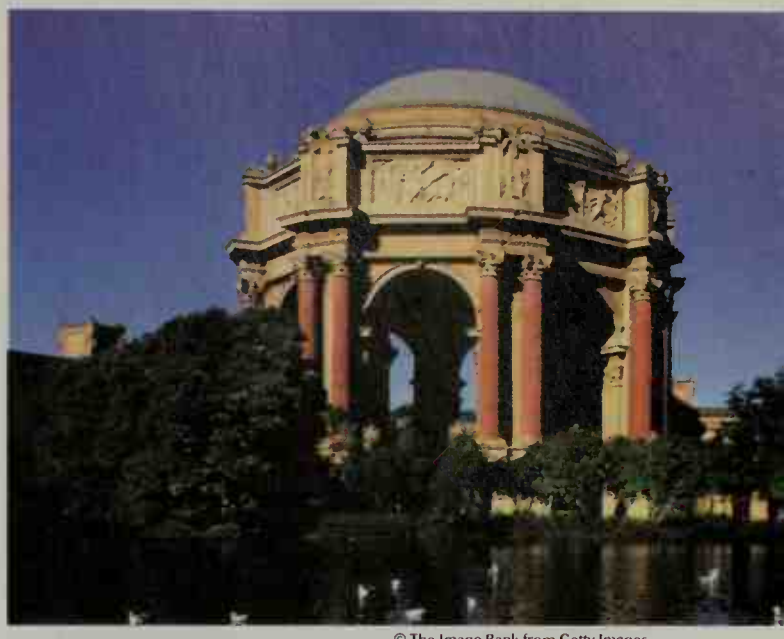
Housing in San Francisco includes many *row houses*. These houses—most of them two-story wood or stucco buildings—may share at least one wall with the house next door. Single families occupy some row houses, but most such houses have been converted into two or more apartments.

Urban renewal projects south and west of the downtown area have replaced many run-down dwellings with attractive row houses and apartment complexes. However, many other older homes and apartments in these areas remain in poor condition.

Education. The San Francisco Board of Education sets policy for the city's more than 100 public schools.

© Stone from Getty Images

Chinatown, in the northeastern part of San Francisco, has one of the world's largest Chinese communities outside Asia.



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The Palace of Fine Arts was built for the 1915 Panama-Pacific International Exposition. It houses a museum, the Exploratorium.

WORLD BOOK map

© Superstock

The Crookedest Street in the World is San Francisco's Lombard Street, which makes eight sharp turns in a single block. It lies on Russian Hill, one of the more than 40 hills in the city.

San Francisco Convention & Visitors Bureau

A cable car carries riders up one of San Francisco's steep hills. The city's cable car system, which includes three lines and covers 10 miles (16 kilometers), is a national historic landmark.

The board consists of seven members who are elected to four-year terms.

San Francisco State University is the city's largest university. The San Francisco campus of the University of California is known for important discoveries in the field of biotechnology. Other institutions of higher learning in the city include City College of San Francisco, Golden Gate University, Hastings College of Law, the San Francisco Art Institute, the San Francisco Conservatory of Music, and the University of San Francisco. Several outstanding universities lie near San Francisco. They include Stanford University in Stanford, near Palo Alto, and the University of California in Berkeley.

Social problems. San Francisco, like other large cities in the United States, faces such problems as poverty, homelessness, crime, and drug abuse. Most of the city's poor lack education and necessary job skills.

San Francisco also has had a high rate of people infected with the life-threatening disease AIDS. The disease first appeared in the city in 1981 among young homosexual men and spread rapidly.

Cultural life and recreation

The arts. The San Francisco Performing Arts Center consists of the War Memorial Opera House, Louise M. Davies Symphony Hall, and the Herbst Theatre. The city's opera company and ballet company perform at the opera house. The opera company, founded in 1923, is the oldest major opera company in the western United States. The ballet company, founded in 1933, is the oldest in the nation. The San Francisco Symphony Orchestra performs at the symphony hall. The Herbst Theatre hosts musical, dance, and theatrical performances. The city's American Conservatory Theater is one of the finest professional theater companies in the United States.

Libraries and museums. The Sutro Library, a branch of the California State Library, includes a collection of books printed during the 1400's. The California Academy of Sciences and the California Historical Society also house fine libraries. San Francisco's public library system has about 25 branches.

The California Palace of the Legion of Honor has collections of antique European furniture, paintings, porcelain objects, and sculptures. It is noted for its works by the French sculptor Auguste Rodin and for its French Impressionist paintings. The collection of the Asian Art Museum spans 6,000 years of history and represents the countries and cultures throughout Asia. The San Francisco Museum of Modern Art specializes in art of the 1900's. The California Academy of Sciences includes the Morrison Planetarium and the Steinhart Aquarium.

Recreation. San Francisco has about 160 parks and playgrounds. Golden Gate Park, the city's chief recreational area, includes baseball diamonds, bridle paths, hiking trails, picnic areas, and tennis courts. Many people enjoy boating in San Francisco Bay, as well as fishing and sailing in the Pacific Ocean and Lake Merced. San Francisco's zoo is near Lake Merced.

The Golden Gate National Recreation Area covers parts of San Francisco and Marin counties. Also in Marin County are Point Reyes National Seashore and Muir Woods National Monument, which has the most famous redwood forest in the country.

The city is the home of the San Francisco Giants of baseball's National League. The San Francisco 49ers of the National Football League also play there.

Economy

San Francisco has long been one of the nation's leading financial centers. It is also a major center of commerce, industry, and tourism.

Finance and trade. Loans from San Francisco's banks played a key role in the early development of the mining industry in the western United States. Today, many banks and other financial institutions operate in the city. The Bank of America, one of the largest commercial banks in the world, has its headquarters in San Francisco. The city is also the home of Wells Fargo Bank, which ranks among the largest U.S. banks.

A number of San Francisco's workers have jobs in

retail and wholesale trade. Many work for firms that serve the tourist trade. Millions of tourists visit San Francisco yearly and contribute greatly to the city's economy.

San Francisco had the busiest port on the Pacific Coast during the 1800's. But several other ports in the Bay Area developed rapidly in the early 1900's. Today, the Port of San Francisco handles far less cargo than some of these nearby ports.

Industry. The San Francisco Bay area lies at the heart of California's high technology industry. The area from Palo Alto southeast to San Jose has so many computer-related industries that it is called Silicon Valley, for the silicon used to make computer chips. San Francisco itself has large numbers of software firms and Internet companies. Many computer graphics and media firms have offices in the city's South of Market district, an area nicknamed Multimedia Gulch.

Other important industries in the San Francisco area manufacture clothing, process food, and fabricate metal products. The city is a leading printing and publishing center. San Francisco is also a major administrative center for industrial firms. More than 100 large U.S. corporations have headquarters in or near the city.

Transportation and communication. San Francisco International Airport, about 12 miles (19 kilometers) south of the city, serves many commercial airlines. The airport ranks among the busiest in the world. Several passenger and freight rail lines also serve the city.

The publicly owned Bay Area Rapid Transit (BART) operates an electric rail system in the bay region. One BART route passes through the Trans-Bay Tube, a tunnel that runs under San Francisco Bay between San Francisco and Oakland. The Trans-Bay Tube, which is 3 $\frac{1}{2}$ miles (5.6 kilometers) long, is the longest underwater vehicular tunnel in North America.

San Francisco's cable cars run on rails and are pulled by a moving cable under the street. The cable car system, which is a national historic landmark, has three lines and covers 10 miles (16 kilometers). The system is part of the Municipal Railway, which also operates buses, trolleys, and light rail vehicles.

San Francisco has two major daily newspapers. They are the *Chronicle* and the *Examiner*.

Government

San Francisco was incorporated as a city in 1850. Its government and that of San Francisco County have been combined since 1856. San Francisco has a mayor-council form of government. The voters elect the mayor and the 11 members of the council, called the Board of Supervisors, to four-year terms. The mayor appoints the heads of the chief city government agencies and prepares the city budget. The mayor may also veto bills passed by the Board of Supervisors.

The city government gets most of its revenue from real estate taxes. But taxes do not meet all the government's expenses. As a result, San Francisco depends on grants from the state and federal governments and on the sale of bonds to pay for improvements.

History

Early days. The Costanoan Indians lived in what is now the San Francisco area long before Europeans arrived. Fogs, which often blanket the Pacific Coast for weeks, probably prevented early European navigators from finding the Golden Gate, the entrance to San Francisco Bay. In 1542, the Portuguese explorer Juan Rodríguez Cabrillo saw the Farallon Islands but missed the Golden Gate. In 1579, the English explorer Sir Francis Drake also sailed right by. He may have anchored in what is now known as Drake's Bay, just north of San Francisco. In 1595, the Portuguese explorer Sebastián Rodríguez Cermeño entered Drake's Bay. He named it *Puerto de San Francisco* (Port of Saint Francis) and so established the name *San Francisco* for the region.

Europeans finally reached the site of San Francisco by traveling overland. In 1769, members of a Spanish expedition led by Gaspar de Portolá became the first Europeans to climb the hills and see the bay.

Settlement by Europeans. On Sept. 17, 1776, a Spanish expedition under Captain Juan Bautista de Anza established a *presidio* (military fort) at San Francisco. During that same year, Spanish priests opened a mission nearby. It was named *Misión San Francisco de Asís* in honor of Saint Francis of Assisi. At the mission, Spanish soldiers and priests subjected the Indians to strict discipline and a heavy workload. A number of Indians were exposed to new diseases. Many became ill and died. The Costanoan population declined greatly during this period.

Spanish-speaking families who came with Anza settled near the mission, known as Mission Dolores after nearby Lake Dolores. The settlement was called the *Pueblo de San Francisco* (Town of Saint Francis).

In 1821, Mexico won its independence from Spain and took over California. Mexico encouraged the development of cattle ranches in its new province of California. The ranches in the San Francisco area attracted New England ship captains, who wanted cattle hides for the growing shoe industry in the eastern United States. A lively port developed in the northeastern corner of the peninsula, and a town named *Yerba Buena* (Good Herb) grew up near the port.

The Mexican War. War broke out between Mexico and the United States in May 1846. On July 9, American naval forces under Commander John B. Montgomery captured Yerba Buena. The Americans renamed the town San Francisco in 1847. Mexico lost the war in 1848, and the entire California region became part of the United States.

The gold rush. In 1848, gold was discovered near what is now Sacramento. The discovery led to the gold rush of 1849. Hundreds of ships, jammed with thousands of gold seekers, streamed into San Francisco's harbor. The fortune hunters, who came from all over the world, swept through San Francisco on the way to the gold fields. Gold-hungry crews abandoned many of their ships in the harbor. San Francisco became the main supply center for the miners. Its population jumped from about 800 in 1848 to about 25,000 in 1849. In 1850, the town was incorporated as a city.

Continued prosperity. Adventurers who made fortunes during the gold rush helped San Francisco become rich. Mansions went up on Nob Hill. Theaters opened and flourished. Commerce boomed. But crime also soared. In 1851, a group of citizens formed the San Francisco Vigilance Committee to enforce law and order. They became known as *Vigilantes* and helped rid the city of a number of its worst criminals. But lawless-

California Historical Society

An earthquake and fire in 1906 left most of San Francisco in ruins. The disaster was one of the worst in U.S. history. At least 3,000 people died, and about 250,000 lost their homes. More than 28,000 buildings were destroyed.

ness still flourished, especially in a district around Pacific Avenue and Kearny Street. In the 1860's, this district was nicknamed the *Barbary Coast,* after a notorious center for sea raiders on the coast of northern Africa.

Following the fabulous California gold strike, mining boom towns sprang up throughout the West. San Francisco became the center of finance and supply for those towns. Manufacturing, especially the production of mining equipment, also thrived in the city.

In 1869, the first railroad from the eastern United States reached the San Francisco Bay area. In 1873, Andrew S. Hallidie, a San Francisco cable manufacturer, invented the cable car. Cable cars provided a safe way to move up and down steep grades and greatly encouraged residential and commercial development on San Francisco's hills. By 1900, the energetic city had a population of about 342,000.

Earthquake and fire. San Francisco suffered one of the worst disasters in United States history when a severe earthquake shook the city at 5:13 a.m. on April 18, 1906. Fires broke out in various sections as stoves and gas lamps overturned, electric wires broke, and gas mains exploded. Firefighters could not battle the flames effectively because the city's water mains had also been damaged. As a result, fires raged unchecked for three days. The firefighters then began to dynamite entire blocks of buildings to stop the spreading flames.

At least 3,000 people died in the disaster, and about 250,000 lost their homes. Most of the city, including more than 28,000 buildings, lay in ruins.

A city reborn. San Franciscans quickly rebuilt their city. In 1915, the new San Francisco held the Panama-Pacific International Exposition to honor the opening in 1914 of the Panama Canal. The canal enabled ships to sail from New York City to San Francisco without having to travel around South America. But Los Angeles and Oakland greatly expanded their port facilities during the early 1900's. As a result, San Francisco lost its position as the leading center of commerce, manufacturing, and shipping in California. The city's population, however, continued to grow steadily. By 1930, it had reached 634,394. The San Francisco-Oakland Bay Bridge opened in 1936 and the Golden Gate Bridge in 1937.

During World War II (1939-1945), San Francisco became one of the world's largest shipbuilding centers. Thousands of new residents, including many African Americans, came to work in the shipyards and other war plants. In addition, thousands of military personnel were stationed in and around the city. San Francisco's population reached a peak of 827,400 in 1945. That same year, delegates from 50 countries met in San Francisco to organize the United Nations (UN).

Building boom. Increasing problems of citywide decay during the 1950's led to large urban renewal projects in the 1960's. Modern row houses and apartment buildings replaced run-down housing in Hunters Point and the Western Addition. Towering new office buildings in downtown San Francisco created an impressive skyline overlooking the bay. The most ambitious project was the huge residential and commercial complex called the Golden Gateway Center.

San Francisco became a center of the counterculture or hippie movement during the middle and late 1960's. Such rock bands as the Grateful Dead and the Jefferson Airplane originated in the city, and thousands of young people flocked there, especially to the Haight-Ashbury district west of downtown.

The downtown building boom continued in the 1970's. The Transamerica Pyramid opened in 1972. That same year, the Bay Area Rapid Transit system began operating. The Trans-Bay Tube opened in 1974. City building codes required that the new structures be built in ways to enable them to withstand earthquakes.

By the 1980's, a debate had reached a peak about the benefits of the city's building boom. Some residents argued that skyscrapers destroyed the city's charm and beauty. Others maintained that the construction was needed to provide jobs and help strengthen San Francisco's economy. In 1985, an ordinance called the Downtown Plan was passed. The plan limited the size of future structures, preserved many existing buildings, and called for open spaces to relieve congestion.

Political leaders murdered. Tragedy struck the city on Nov. 27, 1978, when Mayor George Moscone and Supervisor Harvey Milk were shot to death by Dan White, a former member of the Board of Supervisors. In 1979, White was convicted of voluntary manslaughter and sentenced to a prison term of seven years and eight

months. Many San Franciscans considered the term too light. White was released from prison early, in 1984. In 1985, he committed suicide.

Another earthquake. On Oct. 17, 1989, a strong earthquake—though not as strong as the 1906 quake—struck San Francisco and the surrounding area. It caused 12 deaths and about $3 billion in property damage in San Francisco County. Some San Francisco neighborhoods, especially older ones, suffered severe damage. The earthquake destroyed about 60 buildings in the Marina District, which was built on landfill in the northern part of the city. Other areas of the city escaped major damage, especially newer areas where buildings had been constructed to withstand earthquakes.

Recent developments. San Francisco's population became increasingly diverse during the 1990's. The city's leaders reflected that diversity. In 1995, San Francisco voters elected the city's first African American mayor, Willie Brown. Brown won reelection in 1999. Asian Americans also held several posts in city government. In addition, San Francisco has one of the nation's largest gay, or homosexual, populations, and gays have experienced growing political power.

In the 1990's and the beginning of the 2000's, San Francisco experienced a cultural renaissance. The Yerba Buena Center for the Arts opened. The San Francisco Museum of Modern Art and the Asian Art Museum moved into new homes. Construction began on new, larger facilities for the Jewish Museum San Francisco and the Mexican Museum. James J. Rawls

Related articles in *World Book* include:

Alcatraz
Bank of America
Cable car
California (pictures)
Feinstein, Dianne
Gold rush
Golden Gate Bridge
Oakland
Palo Alto
San Francisco-Oakland Bay Bridge
San Jose

Outline

I. The city
- A. Downtown San Francisco
- B. Residential districts
- C. The metropolitan area

II. People
- A. Population
- B. Housing
- C. Education
- D. Social problems

III. Cultural life and recreation
- A. The arts
- B. Libraries and museums
- C. Recreation

IV. Economy
- A. Finance and trade
- B. Industry
- C. Transportation and communication

V. Government

VI. History

Questions

What is the Golden Gate?
Who were the *Vigilantes*?
What is notable about Lombard Street on Russian Hill?
What organization was set up in San Francisco in 1945?
For what probable reason did early European navigators fail to find San Francisco Bay?
How do San Francisco's cable cars move?
What disaster struck San Francisco in 1906?
How did the gold rush of 1849 affect San Francisco?
What is the oldest building in San Francisco?
What is the Downtown Plan?

San Francisco Conference. Delegates from the United Nations met in San Francisco on April 25, 1945, to form a world organization strong enough to prevent another global war. Representatives of the nations then winning World War II drew up the charter for the United Nations, providing a framework for further cooperation in time of peace.

The United Kingdom, China, the Soviet Union, and the United States sponsored the San Francisco Conference. They originally invited 41 nations to send delegates to the conference. Later, they also invited Lebanon and Syria to attend. When the conference met, it agreed to invite four more countries—Argentina; Denmark; and two republics of the Soviet Union, the Byelorussian Soviet Socialist Republic (now the nation of Belarus) and the Ukrainian Soviet Socialist Republic (now the nation of Ukraine). However, only 50 countries were actually represented because Poland's postwar government had not been formed and could not send a delegation.

After two months of work, the conference drew up the United Nations Charter. The delegates signed it on June 26, 1945. Each nation agreed to fulfill its obligations under the Charter, settle disputes peacefully, cooperate in police actions, and help solve world economic and social problems. Robert J. Pranger

San Francisco-Oakland Bay Bridge is one of the longest bridges in the world over navigable water. It crosses San Francisco Bay between Oakland and San Francisco, California. The Bay Bridge is really a series of bridges. It is more than 8 miles (13 kilometers) long, including its two approaches. It carries two decks for traffic. Opened in 1936, it cost over $76 million.

One part of the Bay Bridge, consisting of two suspension bridges, reaches from San Francisco to Yerba Buena Island in the bay. The roadway passes through a double-deck, 540-foot (165-meter) tunnel. From this tunnel, the bridge crosses to Oakland and Berkeley.

Halfway between San Francisco and Yerba Buena, the suspension spans are anchored to a concrete anchorage pier. The spans themselves are carried by suspension cables supported by towers extending about 500 feet (150 meters) above the water. The two center spans on each side of the anchorage pier are 2,310 feet (704 meters) long. In October 1989, an earthquake caused part of the bridge to collapse. The bridge was repaired, and it was reopened in November. Fred F. Videon

See also San Francisco (picture: Scenic San Francisco).

San Jacinto, *san juh SIHN toh,* **Battle of,** was the last battle of the war for Texas's independence from Mexico. It was fought near the San Jacinto River and Buffalo Bayou in Texas. The Mexican general, Antonio López de Santa Anna, commanded a force of more than 1,200 men. The Texans, under General Sam Houston, had only about 910 men. Following a long retreat, the Texans took the overconfident Mexicans by surprise on April 21, 1836, and won a complete victory in just 18 minutes. Nearly every man in the Mexican army was killed or captured. Santa Anna became a prisoner the next day. The Texan losses were 9 killed and 30 wounded. General Houston was shot in the ankle during the battle. A monument commemorating this battle stands near Houston (see Texas [Places to visit]). Joseph A. Stout, Jr.

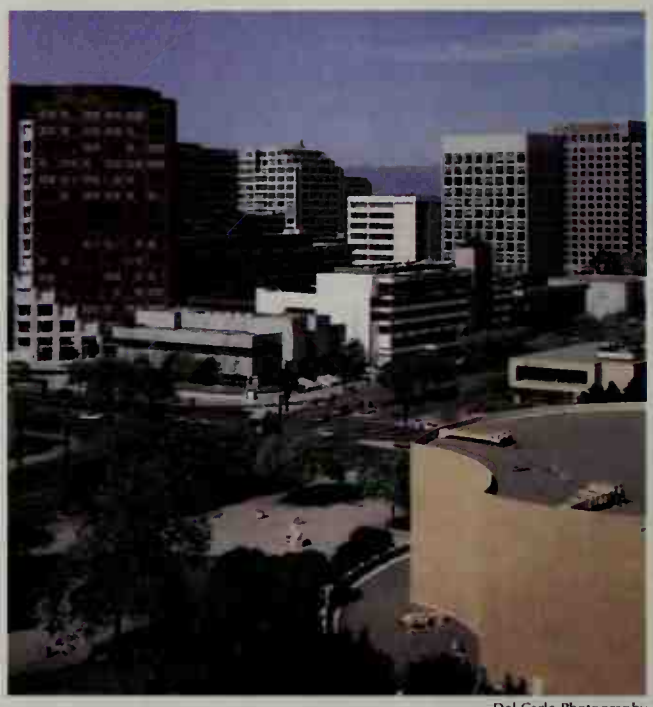
San Joaquin River, *san waw KEEN,* is the chief stream in the southern part of the Central Valley of California. It rises on the western slope of the Sierra Nevada in Fresno County. The river flows southwest out of the

Sierra Nevada and crosses the San Joaquin Valley, one of the richest farming areas in the United States. It then turns northwest and joins the Sacramento River to form a delta. Water from the delta empties into San Francisco Bay. For location, see **California** (physical map).

The San Joaquin River is about 350 miles (563 kilometers) long. Its waters are used in the Central Valley Project, which distributes water for irrigation and for the generation of hydroelectric power. Friant Dam, part of the project, stands on the river. Roger Barnett

San Jose, *SAN hoh ZAY,* is the third largest city in California and a center of high-technology manufacturing and research. Among California cities, only Los Angeles and San Diego have more people.

Spaniards founded San Jose in 1777. They named the town Pueblo de San José de Guadalupe in honor of Saint Joseph. San Jose became California's first capital in 1849. San Jose State University, which opened in 1871, was the state's first public college. Until the 1950's, San Jose was known as a farming center and the home of the college. During the 1950's, however, the city's industry expanded rapidly, and its population greatly increased. Since then, San Jose has continued to be one of the fastest-growing cities in the United States.



Del Carlo Photography

San Jose is California's third largest city, after Los Angeles and San Diego, and it is a center of the high-technology industry.

Facts in brief

Population: *City*—894,943. *Metropolitan area*—1,682,585.
Area: City—170 mi² (440 km²). Metropolitan area—1,305 mi² (3,380 km²).
Climate: *Average temperature*—January, 50 °F (10 °C); July, 69 °F (21 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—14 in (35 cm).
Government: Council-manager. *Terms*—4 years for the mayor and the 10 council members; council hires a city manager.
Founded: 1777. Incorporated as a city in 1850.

Largest communities in the San Jose area

Name	Population
San Jose	894,943
Sunnyvale	131,760
Santa Clara	102,361
Mountain View	70,708
Milpitas	62,698
Palo Alto	58,598
Cupertino	50,546
Gilroy	41,464
Campbell	38,138
Morgan Hill	33,556

Source: 2000 census.

Flag Research Center

Symbols of San Jose. The city's flag and seal were adopted in 1979. The seal depicts grapevines and a sheaf of wheat. These symbols represent prosperity. The seal, which also bears the date San Jose was founded, appears on the flag.

The city. San Jose lies in the Santa Clara Valley, between the Santa Cruz Mountains on the west and the Diablo Range on the east. The city covers about 177 square miles (458 square kilometers) and is the seat of Santa Clara County. The San Jose metropolitan area extends over the entire county—1,305 square miles (3,380 square kilometers).

The heart of downtown San Jose is the intersection of Park Avenue and Market Street. The public buildings in this area include state and federal government office buildings, San Jose's Convention Center, the Center for the Performing Arts, and the Museum of Art.

About 30 percent of San Jose's people are Hispanics. About 27 percent are Asians. In addition, the city's diverse population includes people of European descent, African Americans, and American Indians.

Economy. The more than 3,300 manufacturing plants in the greater San Jose area employ about a fourth of the area's workers. Electronics manufacturing ranks as the leading industry. Products include computers, computer software, semiconductors, and other electronic equipment. The area has become known as the Silicon Valley because of its many computer and computer-related manufacturing and service industries. Silicon is used to make tiny computer chips, a basic part of many electronic devices. The area's other manufactured goods include aerospace products, chemicals, and fabricated metals.

Truck lines and railroad passenger and freight lines serve the city. The San Jose International Airport lies near the downtown area. The city has a daily newspaper, the *San Jose Mercury News.* San Jose has 12 radio stations and 5 television stations. Cable TV systems and Internet providers also serve the area.

Education and cultural life. San Jose's public school systems include about 140 elementary schools, 30 junior high schools, and 20 high schools. The city also has

about 20 private and parochial schools. San Jose State University is in downtown San Jose. Nearby universities include Stanford University near Palo Alto and Santa Clara University in Santa Clara. The San Jose Public Library has 17 branches.

San Jose has a ballet company, four theater companies, an opera company, and a symphony orchestra. They perform in the Center for the Performing Arts and other downtown locations. Museums in San Jose include the Museum of Art, the Children's Discovery Museum, and the Tech Museum of Innovation.

Recreation. San Jose has about 135 parks and playgrounds. Alum Rock Park, the largest, features unusual rock formations and 22 mineral springs. Kelley Park includes a Japanese tea garden and a zoo. It also includes the San Jose Historical Museum's History Park, where visitors may go through a village that recreates life in the city in the 1800's and early 1900's. The San Jose Municipal Rose Garden includes over 4,000 rose shrubs displaying 190 kinds of roses. Rosicrucian Park includes an art gallery, a science museum, and a museum with exhibits on Egyptian history. Rosicrucian Park is operated by the Rosicrucian Order, an international fraternity. The San Jose Sharks of the National Hockey League play in the San Jose Arena in downtown San Jose.

Government. San Jose has a council-manager form of government. The voters elect a mayor and 10 district city council members—all to four-year terms. The council hires a city manager as the administrative head of the government. The city manager carries out council policies, prepares the budget, and appoints and dismisses department heads. San Jose gets most of its income from taxes on property, sales, and utilities.

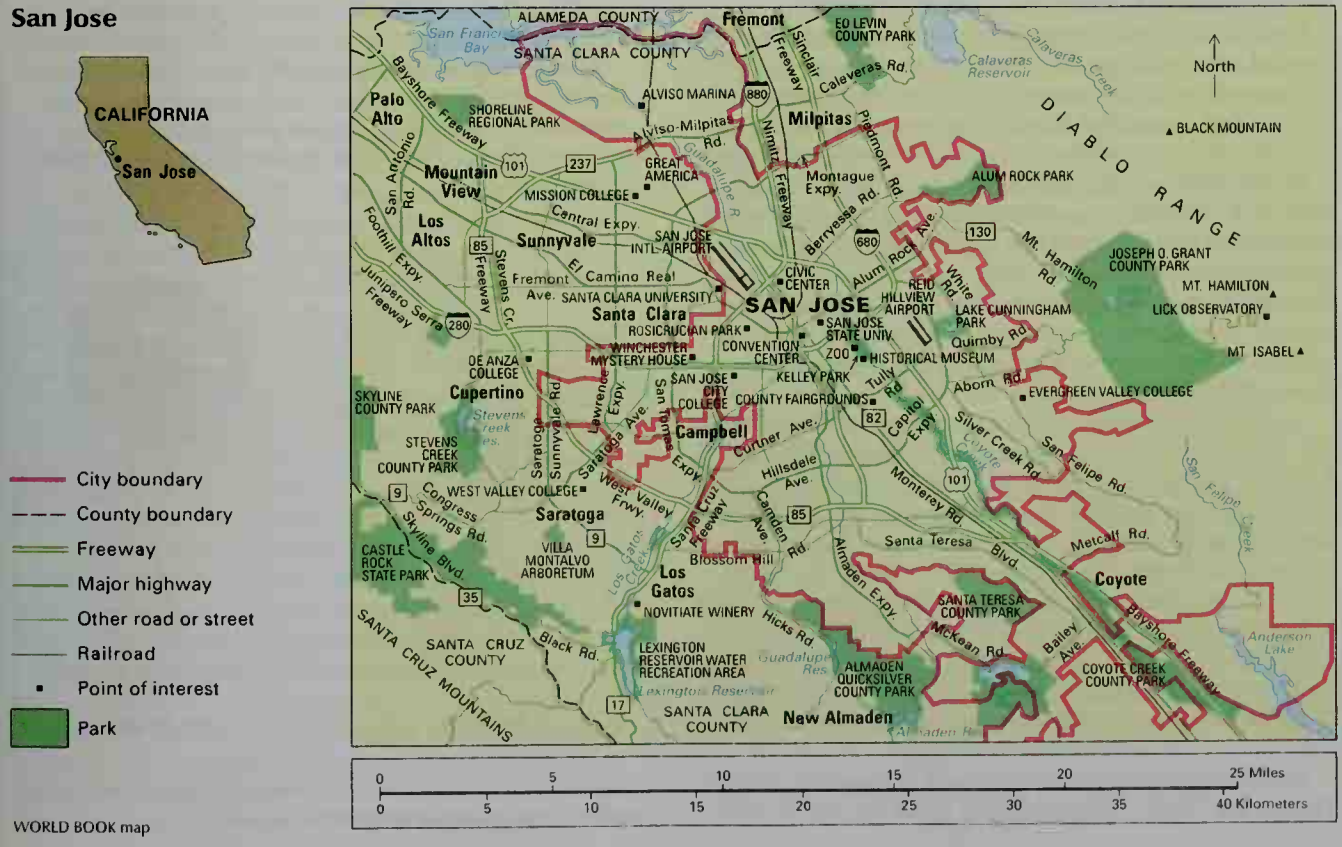
History. The Ohlone Indians lived in the San Jose region before the first European settlers came. In 1777, Spanish colonists founded San Jose on the banks of the Guadalupe River.

San Jose Convention and Visitors Bureau

The San Jose Convention Center is in the center of the city. A striking mural surrounds the main entrance, *shown here.*

The town came under Mexican control during the 1820's. It grew slowly until the 1840's, when American pioneers began to arrive from the East. The United States acquired California from Mexico in 1848. San Jose was California's first capital from 1849 to 1851. In 1850, when San Jose was incorporated as a city, it had a population of about 3,000. That same year, a stagecoach line linked San Jose and San Francisco.

In 1864, a railroad line connected San Jose and San Francisco. The railroad helped cause a land boom in San Jose, and the city's population reached 9,089 by 1870. Agriculture flourished in the San Jose area during the



late 1800's, and apricots, grapes, and prune plums became valuable crops.

During the first half of the 1900's, the city continued to be chiefly a farming and commercial center. In 1950, prune plum orchards covered about 86,000 acres (34,800 hectares) near San Jose, and the city was known as the prune capital of the world.

Manufacturing grew rapidly in the area in the 1950's. The aerospace and electronics industries built large plants there, and the area began to shift from a rural, farm economy to an urban, industrial economy. Jobs created by the new industries caused a population boom in San Jose. By 1960, the city had more than 200,000 people.

San Jose started to annex nearby vacant land during the 1950's. Between 1950 and 1980, the city's area increased from 17 to 157 square miles (44 to 407 square kilometers). Large housing developments spread across former orchards and pastures. The loss of farmland caused the area's once-thriving canning and food processing plants to move elsewhere. But further industrial expansion helped San Jose continue to grow. By 1980, the city's population had increased to about 630,000.

In 1968, work began on a downtown urban renewal project called Park Center Plaza. This project, completed in the late 1980's, included construction of several banks, office buildings, and a hotel. In the 1980's and 1990's, work on another downtown urban renewal project, the Silicon Valley Financial Center, included the construction of new condominiums, a hotel, movie theaters, retail space, rental housing, an office tower, a repertory theater, and an art museum.

In October 1989, a destructive earthquake struck the San Jose-San Francisco-Oakland area. It caused about $700 million in property damage in Santa Clara County. However, there was much less damage within the city of San Jose than in some of the surrounding area.

By 2000, San Jose's population had grown to 894,943. Several problems resulted from the city's rapid growth. Transportation and sewerage systems nearly became overloaded. In spite of much construction, growing demand for housing helped cause soaring housing prices.

In July 2000, construction began in the downtown area on a new library, a center combining the city's main library with the library of San Jose State University. Completion was scheduled for 2003. Bob Johnson

San José, *SAHN haw SEH* (pop. 318,765), is Costa Rica's capital, largest city, and commercial center. It lies on a plateau in the country's main agricultural region (see **Costa Rica** [political map]).

San José has a modern appearance and a mainly middle-class population. Important landmarks include the National Theater and the National Museum. The National Theater is an elaborately decorated center for the performing arts built in 1897. The National Museum is housed in a fortress that dates back to 1832.

San José is the center for trade in coffee, bananas, and sugar produced in Costa Rica. It has numerous factories that process foods and manufacture chemicals, textiles, and furniture. Railroads link San José to ports on the Caribbean Sea and the Pacific Ocean. Juan Santamaría International Airport also serves the city.

Spanish settlers founded San José in the mid-1700's. During the 1980's, the population grew rapidly as a result of a steady flow of refugees from nearby war-torn countries. Nathan A. Haverstock

See also **Costa Rica** (picture).

San Jose scale, *SAN hoh ZAY,* is an insect pest that feeds on many kinds of fruit trees, shade trees, and ornamental shrubs. The insect is named after the city in California where it was first seen in the United States. The San Jose scale is native to China. It was imported into the United States accidentally, probably during the late 1870's in a shipment of ornamental peach trees. The scale spreads rapidly on infested trees and shrubs. It is now a common pest in orchards and nurseries throughout the United States and southern Canada.

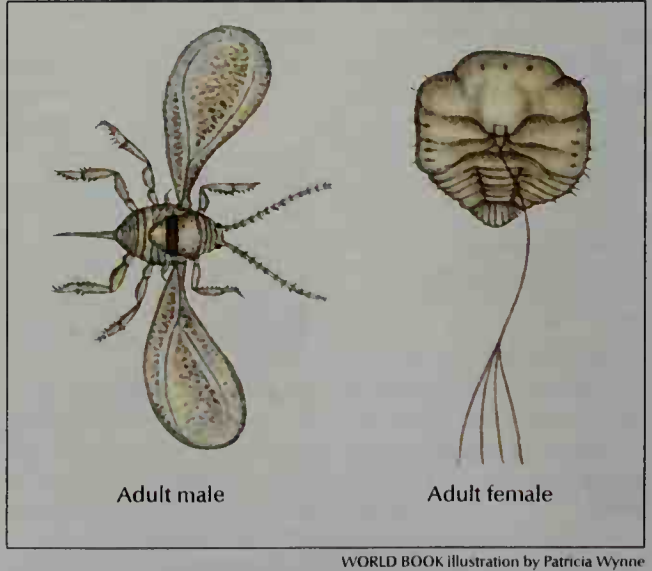
The San Jose scale most commonly affects trees in the rose family, including apple, cherry, peach, pear, and plum trees. The insects may weaken a tree or reduce its yield of fruit. Heavy infestations can kill a young tree within two or three years.

Young scales, known as *crawlers,* have lemon-yellow bodies. They resemble ticks with six short legs. Crawlers suck sap out of the plants they live on with long, slender mouthparts. After feeding begins, the insect secretes a protective covering, called a *scale,* over its body. As it grows, the insect sheds its legs and then cannot move. Crawlers grow into adults in six to eight weeks in the summer. Only immature scales survive the winter.

A mature scale cover is no larger than a pinhead. Beneath the cover, a female's body is soft and saclike. She has no legs or wings and never leaves her covering. Adult males leave their scale cover to fly in search of females. The males have two delicate wings, antennae, six legs, and a distinctive brown stripe across the back. The females release a scent that attracts males for mating. Each female may produce 300 to 400 live young (crawlers) before she dies.

Ladybird beetles, wasps, and mites prey on the San Jose scale. Most insecticides cannot penetrate the scale's protective cover. However, in late winter, many fruit growers spray their trees with an oil that coats and suffocates the scale insects. John R. Meyer

Scientific classification. The San Jose scale is in the armored scale family, Diaspididae. Its scientific name is *Quadraspidiotus perniciosus.*



WORLD BOOK illustration by Patricia Wynne

The San Jose scale is a destructive insect.

San Juan, *san HWAHN* (pop. 421,958; met. area pop. 1,967,627), is the capital and largest city of Puerto Rico. It is also the island's chief seaport (see **Puerto Rico** [political map]). The older part of the city lies on an island off the northern coast of Puerto Rico. Newer residential districts lie on the main island. Four bridges and a highway over the water link these sections. Trade, manufacturing, and government are the chief activities. Some of the Spanish forts and the walls around the older part of the city are over 250 years old. San Juan National Historic Site, covering 48.25 acres (19.53 hectares), contains many of these fortifications. Morro Castle, begun in 1539 and completed in the late 1700's, lies on a bluff at the entrance to the bay, which is one of the best harbors in the West Indies.

The Center for Advanced Studies on Puerto Rico and the Caribbean and a campus of the University of Puerto Rico are in San Juan. Nearby Santurce is the home of the University of the Sacred Heart and the Conservatory of Music of Puerto Rico.

In 1521, followers of Ponce de León founded San Juan. It served as the seat of the Spanish provincial government. Fernando Bayrón-Toro

See also **Puerto Rico** (pictures).

San Juan Capistrano, *san HWAHN KAP uhs TRAH noh,* California (pop. 33,826), is a city 60 miles (97 kilometers) southeast of Los Angeles (see **California** [political map]). The city grew up around a mission founded in 1776. The mission is known for the swallows that leave every year about October 23 to winter in the south and return to Capistrano about March 19. Kenneth Reich

San Juan Hill, Battle of. See **Spanish-American War** (Land battles; map).

San Lorenzo, Treaty of. See **Pinckney Treaty.**

San Luis Potosí, *SAHN loo EES POH toh SEE* (pop. 669,353), is a farming and mining center in central Mexico. The city stands 225 miles (362 kilometers) northwest of Mexico City. It is the capital of the state of San Luis Potosí. For location, see **Mexico** (political map).

Spanish-style churches, public buildings, and houses from the 1600's stand in San Luis Potosí. Many people work in nearby silver, lead, and gold mines. The city is an important air and rail center. It stands on the highway between Mexico City and Eagle Pass, Texas. Industries include an aircraft plant, flour mills, textile mills, tanneries, breweries, furniture factories, and metal refining and smelting plants. Roderic A. Camp

San Marcos, *sahn MAHR kohs,* University of, in Lima, Peru, is the oldest university in South America. It is also called the University of Lima. The school was founded in 1551 by King Charles I of Spain. Dominican friars supervised the university until 1571. During the 1600's and 1700's, the university was noted for its schools of law and medicine. The university was closed during the early 1800's and reopened in 1861. It became a government-supported institute in 1874. Today, it offers courses in dentistry, economics, education, journalism, law, linguistics, literature, medicine, pharmacy, science, and veterinary medicine. The university has an enrollment of about 34,000. P. A. McGinley

San Marino, *SAN muh REE noh,* is a small European country that is surrounded by Italy. It lies in the Apennine Mountains of northeastern Italy. Much of it—including its capital and largest city—stands on Mount Titano. The capital is also called San Marino. San Marino is one of the smallest countries in the world. It covers only 24 square miles (61 square kilometers).

San Marino is the oldest republic in the world. The country has been independent since the A.D. 300's. Its official name is La Serenissima Repubblica di San Marino (The Most Serene Republic of San Marino).

San Marino is a popular tourist center. Visitors enjoy the country's spectacular views, fortress walls, cakes and wine, and colorful festivals. San Marino is also known for its beautiful postage stamps.

Government. San Marino is a republic. A legislature called the Grand and General Council makes the country's laws. The people elect the 60 council members to five-year terms. The council selects two of its members to head the government. These two officials, known as *captains-regent,* serve for six months and cannot be reelected for three years. They appoint the heads of the 10 departments of the government. The captains-regent and heads of the government departments make up the Congress of the State. Twice a year, the heads of all the families in San Marino meet—as they have for centuries—to discuss public matters. Political parties in San Marino are generally similar to those in Italy and have the same names.

People. San Marino's people are closely related to the people of northern Italy. Nearly all San Marinese are Roman Catholics and speak Italian, and their customs are like those of Italy. However, the people of San Marino are proud of their long tradition of independence, and many of their holidays honor events in the nation's history.

Many of San Marino's people work in the tourist industry, which includes hotels, restaurants, and souvenir shops. Other people work in stone quarries or make leather or cheese. San Marinese farmers raise cattle and sheep and grow such crops as grapes and wheat.

Nearly everyone in San Marino can read and write. The law requires children from the ages of 6 to 14 to attend school. After elementary and secondary school, many students attend schools of higher education in Italy.

Most homes have a telephone, radio, and TV. Motion pictures are a popular form of entertainment.

Land. San Marino lies in the rugged terrain of the eastern Apennine Mountains near the Adriatic Sea. Mount Titano, the country's highest mountain, is 2,478

Facts in brief

Capital: San Marino.
Official language: Italian.
Area: 24 mi² (61 km²).
Elevation: *Highest*—Mount Titano, 2,478 ft (755 m). *Lowest*—Ausa River at northern border, 164 ft (50 m) above sea level.
Population: *Estimated 2002 population*—28,000; density, 1,167 per mi² (459 per km²); distribution, 88 percent urban, 12 percent rural. *1976 census*—19,149.
Chief products: Barley, fruits and vegetables, wine, wheat, building stone, ceramics, leather goods, textiles, tiles, varnish.
Flag: The flag has a blue and a white horizontal stripe. The state flag, used by the government, has a coat of arms in the center. The national flag, used by the people, does not have a coat of arms. See **Flag** (picture: Flags of Europe).
Money: *Basic unit*—euro. One hundred cents equal one euro. The Italian lira was taken out of circulation in 2002.

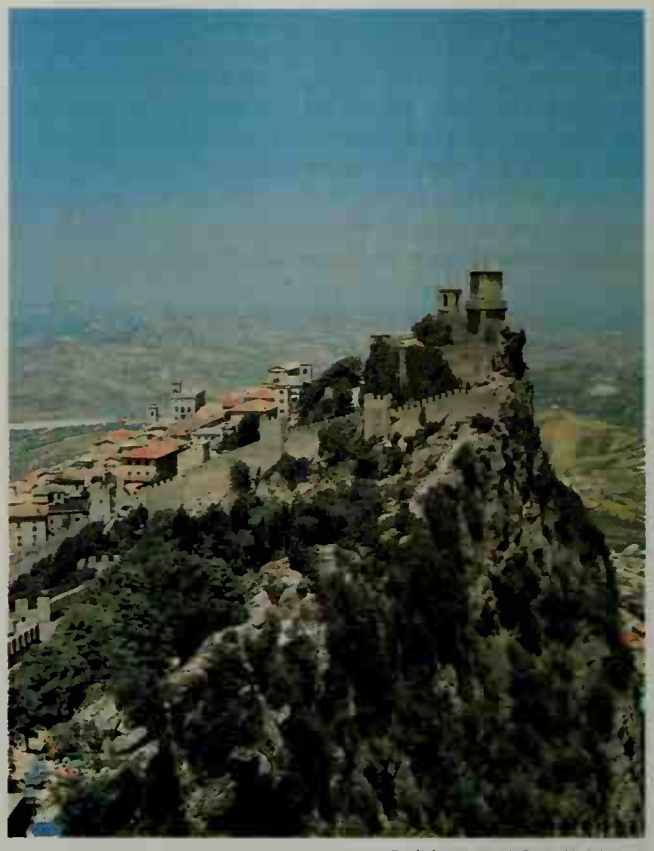
feet (755 meters) high and has three peaks. On top of each peak is a tower built during the Middle Ages. The capital, San Marino, is near the top of the mountain. A highway and a railroad link the country with Rimini, the nearest Italian city. A helicopter service provides transportation to and from Rimini during the summer.

San Marino has a mild summer climate, with a temperature that averages about 75 °F (24 °C). Winter temperatures sometimes fall below freezing. The country has an average annual rainfall of 35 inches (89 centimeters). The soil in San Marino is poor and rocky. However, the mild climate and ample rainfall enable farmers to grow a variety of crops.

Economy. The tourist trade provides San Marino's chief source of income. More than $2\frac{1}{2}$ million tourists visit the country yearly. Farming and construction materials also play important roles in the economy. The principal farm products include animal hides, barley, chestnuts, wheat, vegetables, and fruit. The fruits include grapes, from which wine is made. Building stone and lime from mountainside quarries are exported to Italy. Manufactured products of San Marino include ceramics, leather goods, tiles, varnish, and textiles.

Two other sources of income for San Marino are the sale of postage stamps and an annual payment from Italy. San Marinese postage stamps are prized by collectors throughout the world. The Italian government pays San Marino for certain privileges. These privileges include the right to tax San Marinese goods shipped through Italian ports and to supply all of San Marino's salt and tobacco.

History. According to tradition, San Marino was founded in the A.D. 300's by a Christian stonecutter named Marinus. Marinus, for whom the country was named, fled to Mount Titano to escape religious persecution by the Romans. An independent religious community had grown up in San Marino by 885, and a republic was established by the 1300's. During the next



Guglielmo Mairani, Grazia Neri Agency

San Marino is one of the smallest countries in the world. Its picturesque capital, also called San Marino, *above,* lies on Mount Titano and is surrounded by a stone wall.

200 years, the citizens of San Marino defended their republic against plots by, and attacks from, neighboring states. In 1631, the independence of San Marino was formally recognized by the pope, who controlled the surrounding territory. Later popes opposed attempts by some Italian cardinals to take over the tiny country.

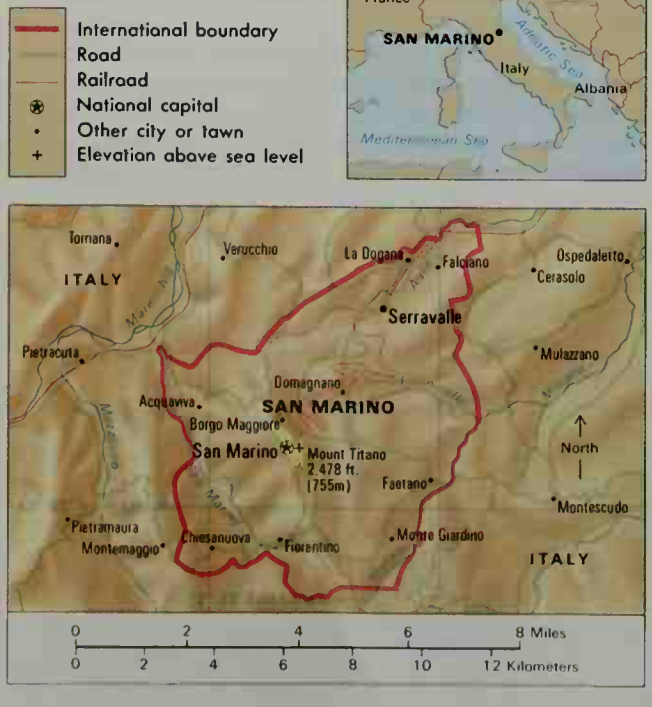
The territory surrounding San Marino became part of the kingdom of Italy in 1861. San Marino and Italy signed a treaty of friendship in 1862. Renewed in 1877, this treaty has governed relations between the two countries since that time. During most of World War II (1939-1945), San Marino was officially neutral, but Fascists controlled the government. The British bombed the country once in 1944.

From 1945 to 1957, a coalition of Communists and Socialists held a majority of seats in the Grand and General Council. The Christian Democratic Party gained control of the council in 1957 and governed the country for the next 20 years. Since the elections of 1978, a coalition of Communists, Socialists, and others on the political left has usually held power. William M. Reddy

San Marino, *san muh REE noh* (pop. 4,161), is the capital and largest community of the country of San Marino. San Marino lies high on Mount Titano. A high stone wall originally constructed during the Middle Ages surrounds San Marino. The wall connects three towers, one of which stands on each of the three peaks of Mount Titano. The towers are symbols of the country, and they appear on its flag. From the towers, people can view the surrounding countryside and the Adriatic Sea, which lies 12 miles (19 kilometers) to the northeast.

San Marino

WORLD BOOK maps



San Marino developed during the Middle Ages. It has a church that dates from the 1300's, many old houses, and winding, cobblestoned streets. During the 1800's, the town hall and a church were built in the Gothic style of the Middle Ages, and the town wall was rebuilt. Most of the city's shops and offices are in Borgo Maggiore, a suburb 600 feet (180 meters) below the wall.

William M. Reddy

San Martín, *sahn mahr TEEN,* **José de,** *hoh SAY day* (1778-1850), was an Argentine general who helped lead the struggle for independence in South America against Spain. He is Argentina's greatest hero.

San Martín was born on Feb. 25, 1778, at Yapeyú, near present-day Paso de los Libres, Argentina. When he was 7 or 8 years old, his parents returned to their homeland, Spain. San Martín became an army officer and served with Spanish forces for 22 years. He helped defend Spain against invading French forces of Napoleon Bonaparte from 1808 to 1811. Then San Martín resigned his commission and went to join Argentina's struggle for independence.

In 1812, revolutionaries in Buenos Aires gave him command of a military unit. In 1816, under San Martín's leadership, Argentines declared their independence from Spain.

Granger Collection

José de San Martín

San Martín then joined forces with the Chilean patriot Bernardo O'Higgins. In January 1817, San Martín and O'Higgins led an army over a pass nearly 15,000 feet (4,600 meters) high in the Andes Mountains. The army appeared before the astonished Spaniards in Chile and won the Battle of Chacabuco near Santiago on February 12. The patriot army won a second victory near the Maipo river in north-central Chile in April 1818. This victory led to Chile's independence.

In 1820, San Martín led an army to Peru. He declared the country free in 1821. The next year, he met Simón Bolívar, another leader in the fight for South American independence. San Martín then left to Bolívar the task of winning formal recognition of Peru's independence.

Back home in Argentina, San Martín became discouraged by political disputes. He was also saddened by the death of his wife in 1823. In 1824, San Martín left for Europe, where he died. Nathan A. Haverstock

See also **Argentina** (Independence; picture: José de San Martín); **Chile** (History); **Flag** (pictures: Historical flags of the world [Latin-American flags]); **Peru** (The war of independence).

San Pedro Sula, *sahn PAY droh SOO lah* (pop. 326,943), is the second largest city in Honduras. Only Tegucigalpa has more people. San Pedro Sula lies north of the Chamelecón River. For location, see **Honduras** (map). The city is a center of manufacturing and trade. The city's industries include brewing, sugar milling, and the manufacture of candles, cigarettes, clothing, concrete, margarine, plastics, shoes, soap, steel, and textiles. Gary S. Elbow

San Quentin is California's oldest prison. It was opened in 1852 and is in Marin County, near San Francisco. The prison has a normal capacity of about 2,700 prisoners but has held as many as 3,900. Its official name is the California State Prison at San Quentin.

San Quentin is a *maximum security prison.* Such institutions hold prisoners convicted of violent crimes, and offenders who have been imprisoned repeatedly. Overcrowded living conditions and racial tensions have resulted in many killings, riots, and suicides at the prison. In 1983, a Marin County court found that due to conditions at the prison, most prisoners at San Quentin had suffered "cruel and unusual punishment." Such punishment is forbidden by the U.S. Constitution. Some prison experts have urged that the prison be closed.

The prison administration works to provide counseling, education, and other programs for the prisoners. But conditions at San Quentin have made any reform of prisoners extremely difficult. James O. Finckenauer

San Salvador, *san SAL vuh DAWR* (pop. 415,346), is the capital and largest city of El Salvador. The city lies near the center of the country about 25 miles (40 kilometers) from the Pacific Ocean. For location, see **El Salvador** (political map). An estimated 1,500,000 people live in the San Salvador metropolitan area.

San Salvador's chief products include chemicals, processed foods, and textiles. Highways connect the city with the rest of El Salvador. The Pan American Highway links San Salvador to other Central American cities and to cities in Mexico and the United States. An international airport also serves San Salvador.

San Salvador was founded in 1525. A few years later, the city was moved south to its present site in a valley near a volcano. Earthquakes in this area have greatly damaged the city on several occasions and killed thousands of people.

During the 1980's, conflict between government troops and rebel forces in El Salvador developed into a civil war. Thousands of people fled the violence in rural areas of the country and settled in slums on the outskirts of San Salvador. William V. Davidson

San Salvador Island. See **Bahamas.**

Sanaa, *sah NAH* (pop. 427,185), is the capital and largest city of Yemen. It lies in the western part of the country in a fertile district of a mountainous region. For the location of Sanaa, see the map in the **Yemen** article. The city is an economic, political, religious, and educational center of Yemen.

Sanaa is shaped like a figure 8. Its central district is surrounded by a high wall. The seven-story Republican Palace, a government office building, stands at its center. Sanaa has about 50 *mosques* (Muslim houses of worship). Many of Sanaa's buildings are five to nine stories tall and have white plaster decorations that look like lace against the reddish-brown brick walls. Most of Sanaa's people work as craftworkers, government officials, or laborers. Sanaa is an ancient city, but its founding date is unknown. Robert Geran Landen

Sanatorium. See **Sanitarium.**

Sánchez, George Isidore (1906-1972), an American educator, was a leading spokesman for educational reforms for Spanish-speaking students in the United States. He called attention to the relation between the extreme poverty and the educational problems of Span-

ish-speaking Americans. Sánchez urged schools in Spanish-speaking communities to offer *bilingual education,* using Spanish-speaking teachers and teaching various subjects in Spanish. He also proposed greater study about the contributions of Mexican Americans.

Sánchez wrote several books and magazine articles, but his proposed reforms remained largely unrecognized until the 1960's. At that time, the Chicano movement focused attention on the need for bilingual education and other reforms in Spanish-speaking communities. Sánchez's book *Forgotten People: A Study of New Mexicans* (1940) is now considered a classic sociological study.

Sánchez was born on Oct. 4, 1906, in Albuquerque, New Mexico. He received a doctor's degree in education from the University of California at Berkeley in 1934. He was a professor of Latin American education at the University of Texas from 1940 until his death.

Jesús Chavarría

Sancho Panza. See Don Quixote.

Sanctions, Economic, are actions that one or more countries take to limit or end their economic relations with a target country to try to persuade that country to change its policies. Economic sanctions hurt the target country by preventing it from selling its products or buying the products it wants. Sanctions are usually withdrawn once the target country improves its behavior.

Economic sanctions can take many forms. An *embargo* limits or prevents the shipment of goods to or from the target country. During a *boycott,* a country refuses to buy goods from the target country. A sanctioning country may raise *tariffs* (import taxes) on goods produced by the target country. It can also refuse to grant loans or other assistance to the target country. In some cases, a country may prevent citizens or businesses of the target country from using the property, bank accounts, and other assets they hold in the sanctioning country.

International organizations often encourage members to impose sanctions on countries that engage in unacceptable behavior. For instance, the United Nations coordinated sanctions against North Korea in 1950 for its invasion of South Korea, against South Africa in 1985 for its policy of *apartheid* (racial segregation), and against Iraq in 1990 for its invasion of Kuwait.

Many people argue that economic sanctions often fail to achieve the desired policy changes. Some argue that economic sanctions harm innocent people by preventing shipments of goods such as food and medicine. Nevertheless, sanctions remain a popular means of attempting to influence countries' behavior and enforcing international law. T. Clifton Morgan

See also **Boycott; Embargo; Tariff.**

Sand is a loose accumulation of tiny pieces of rocks or minerals that are larger than silt or clay but smaller than pebbles. Scientists define sand as grains that measure from $\frac{1}{400}$ inch (0.06 millimeter) to $\frac{1}{12}$ inch (2.1 millimeters) in diameter.

Most grains of sand once formed parts of solid rocks that have crumbled away. Rocks break and crumble by the process of *weathering.* For example, waves pounding against a coastline wear away rocks. When water freezes in the cracks of rocks, it can cause them to split apart. Rocks also may break down as a result of chemical reactions with air and water.

Sand is widely distributed over the earth. It lies at the bottom of the sea and many lakes. Large amounts of sand wash up from shallow sea bottoms onto beaches. Sand also rolls along the bottom of rivers and may be deposited by the rivers over lowland areas. In desert areas, sand covers vast stretches of land. Wind may pile up the sand in low hills called *dunes.*

Sand may be composed of many types of material. Quartz is the most common mineral in sand. But sand also may include other minerals, such as feldspar, and fragments of rocks. Some sand beaches are made up mostly of the mineral *calcite,* which comes from broken shells and coral. Black sand found in Hawaii and on other Pacific Islands consists of grains of *basalt* and *basaltic glass,* which are rocks formed from the hardened lava of volcanoes.

Sand has important industrial uses. Sand and gravel are mixed with cement to make concrete. Manufacturers use a pure form of quartz sand called *silica sand* to make glass, abrasives, furnace linings, and scientific molds. Some river deposits of sand called *placers* may also contain small amounts of such precious substances as gold, platinum, and diamonds. Finley C. Bishop

Related articles in *World Book* include:

Beach	Dune	Loam	Sandstorm
Desert	Glass	Sandstone	Silica

Sand, George (1804-1876), was the pen name of Amantine-Aurore-Lucile Dupin, a French novelist of the 1800's. Her work was admired by the greatest writers of her time. After her death, Sand's writing went out of style, and she was remembered only for her shocking lifestyle and her love affairs with the composer Frédéric Chopin and the poet Alfred de Musset. She defied social convention by smoking cigars and wearing men's clothes. Since the emergence of the women's movement in the mid-1900's, Sand's work has been rediscovered, and she has attracted critical attention as a novelist and autobiographer.

Chicago Historical Society

George Sand

Sand was born on July 1, 1804, in Paris and grew up in the tiny village of Nohant. She went to Paris in 1831 to write. Her many works can be divided roughly into four periods. Her first works were novels of romantic passion, notably *Indiana* (1832), *Valentine* (1832), and *Lélia* (1833). These novels protest against the socially defined condition of women and reflect her own emotional desires and disappointments. They plead for a woman's right to sincere love and to lead her own life. Beginning about 1840, Sand expressed her concern with social problems in such novels as *Consuelo* (1842-1843). In the mid-1840's, she wrote original novels of life in the French provinces. These include *The Devil's Pond* (1846), *François the Waif* (1848), and *Little Fadette* (1849). Her later writings include two volumes of children's stories, *A Grandmother's Tales* (1873, 1876).

Sand was also a playwright, travel writer, and journalist. Today, her memoirs and correspondence are among

her most interesting works, especially *The Story of My Life* (1854-1855). Thomas H. Goetz

Additional resources

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Naginski, Isabelle H. *George Sand.* Rutgers, 1991.

Sand dollar is an animal that lives slightly buried in the sand in shallow coastal waters. Its thin, circular body is about 2 to 4 inches (5 to 10 centimeters) wide. Its dried skeleton looks like a large, white coin. A living sand dollar resembles a fuzzy brown cookie.

The bodies of many species of sand dollars contain

Alex Kerstitch

A sand dollar has a thin, circular body.

slots or notches. Sand moves up through the slots when the animal buries itself. A sand dollar has many tiny, movable spines, which it uses to dig and crawl. The top surface of the body has small breathing structures arranged in the shape of a five-pointed star. A sand dollar's mouth is in the center of the undersurface. The animal eats tiny aquatic organisms that it finds among the sand grains or traps from the surrounding water.

A sand dollar releases eggs from small openings near the center of the top of the body. They develop into free-swimming larvae. The larvae eventually sink to the ocean floor and grow into adult form. John C. Ferguson

Scientific classification. Sand dollars belong to the phylum Echinodermata, class Echinoidea.

See also Echinoderm.

Sand fly is a hairy, dark-brown insect that measures about $\frac{1}{8}$ inch (3.2 millimeters) long. Female sand flies are active at night, and suck blood from human beings and animals. The *larvae* (young sand flies) live in moist places and feed on decaying plant and animal matter.

About six kinds of true sand flies live in the southern United States. But several hundred kinds thrive in the tropics and subtropics. They transmit germs that cause such serious diseases as kala-azar and sand fly fever.

Moth flies are related to sand flies, but they do not suck blood. Their wings fold over the body like a roof. Biting *midges* are sometimes called sand flies. In spring and fall, biting midges may appear in swarms. They rank among the smallest blood-sucking insects. Some are only $\frac{1}{25}$ inch (1 millimeter) long. E. W. Cupp

Scientific classification. Sand flies, moth flies, and biting midges are all in the true fly order, Diptera. Sand flies and moth flies belong to the family Psychodidae. Biting midges are in the family Ceratopogonidae.

Sand painting is the name for making pictures in sand. The Navajo Indians of the southwestern United States are noted for their sand painting, also called *dry painting.* The paintings are a part of many ceremonies, especially healing rites. In healing ceremonies, the sand painting serves as an altar that portrays the gods and the gods' homeland. The patient sits in the center of the painting to symbolically receive healing of the gods.

Medicine men and medicine women get colored sands by grinding stones from nearby cliffs. They make the designs freehand and from memory, and destroy them after the ceremonies. Sand paintings were made in Japan in the A.D. 600's, and in England and France during the 1700's and 1800's. Delilah Orr

See also Folklore (picture: Many religious ceremonies).

Sand verbena is a low-growing summer annual with fragrant pink, white, or yellow flowers. The blossoms resemble those of the verbena, but the two plants are not related. There are about 25 species of sand verbenas, and all are native to western North America. The plants grow best in open, sunny places and in light soils. They are used for rock and seaside gardens. They adapt well to desert conditions. W. Dennis Clark

Scientific classification. Sand verbenas belong to the four-o'clock family, Nyctaginaceae. They make up the genus *Abronia.*

Sandalwood is a scarce, valuable wood taken from several related trees that grow in India, Indonesia, and Australia. Sandalwood has a fairly straight grain. The wood also has a fine structure and is so heavy that it will barely float in water. The *heartwood* (center) has a yellowish-brown or dark reddish-brown color.

Sandalwood has a fragrant odor from an oil it contains. Most sandalwood is shipped to China, where it is used in funeral ceremonies, for carving, and for incense in temples. It is well suited to making carved boxes, jewel cases, fans, combs, picture frames, and walking sticks. The oil is obtained by distilling the wood. The oil is used in perfumes, cosmetics, and medicines. Jim L. Bowyer

Scientific classification. Sandalwood trees make up the family Santalaceae and the genus *Santalum.* The scientific name for the principal species is *S. album* of India.

Sandblasting is a method for engraving such materials as glass and granite or for cleaning metal and some buildings. Compressed air forces sand through a hose from the blasting machine. The sand acts as an abrasive to wear away scale on metal, dirt on stone buildings, or to smooth the surface of glass. Machines that have a rapidly rotating bladed wheel to hurl metal abrasives, particularly steel shot, are also used. Manufacturers prefer this method because it is faster and costs less. See also Glass (How glass is decorated). Melvin Bernstein

Sandbur, also called *bur grass,* is a troublesome prickly weed that originally came from the plains of the western United States. It now grows in sandy places in almost all temperate and tropical countries. A closely related species called the *cockspur* is common in the South. The stem of the plant grows from 1 to 2 feet (30 to 60 centimeters) high. It bears spikes with 10 to 20 shiny, sharp-spined burs that cause painful wounds when they prick the flesh. Harold D. Coble

Scientific classification. Sandbur is in the grass family, Poaceae or Gramineae. Its species belong to the genus *Cenchrus.*

See also Plant (How seeds are dispersed).

Sandburg, Carl (1878-1967), was an American poet, biographer, and historian. Two major themes dominate

his works. One theme is a search for the meaning of American history. The other involves Sandburg's enthusiasm for the American common man. Quoting the English writer Rudyard Kipling, Sandburg said of himself: "I will be the word of the people. Mine will be the bleeding mouth from which the gag is snatched. I will say everything."

Schaal, Pix

Carl Sandburg

Sandburg was born on Jan. 6, 1878, in Galesburg, Illinois. He left school at the age of 13 and did odd jobs around Galesburg for several years. Sandburg described his boyhood in the small Midwestern town in his highly praised autobiography, *Always the Young Strangers* (1953). Its sequel, *Ever the Winds of Chance* (1983), was published after his death and describes the years from 1898 to 1907.

When he was about 18, Sandburg traveled throughout the Midwest as a hobo. After the Spanish-American War began in 1898, he served briefly in the U.S. Army in Puerto Rico. That same year, he returned to Galesburg, where he attended Lombard College. He left college in 1902 without graduating. For about 10 years, he was active in Socialist Party politics in Wisconsin.

Sandburg worked as a newspaper writer, primarily in Chicago, from 1912 to the late 1920's. He first won fame—for his poetry—during that time. Then the success of the first part of his great biography, *Abraham Lincoln,* enabled him to leave journalism and concentrate on a literary career. Sandburg was one of several important American writers who lived in Chicago from about 1912 to the mid-1920's. These writers included Sherwood Anderson, Theodore Dreiser, Ben Hecht, and Edgar Lee Masters. They are often called the *Chicago School.*

His poetry. One of Sandburg's best-known early poems, "Chicago" (1914), portrays the brutality and ugliness he saw in American cities. It also pays tribute to the energy and power of modern industry. In making the city his subject, Sandburg followed a tradition in American poetry that began with Walt Whitman during the mid-1800's. In form, style, and theme, many of Sandburg's works resemble the poems in Whitman's collection, *Leaves of Grass.*

After 1920, Sandburg began to collect American ballads, folk tales, and legends. He presented many ballads and folk songs in *The American Songbag* (1927).

Sandburg introduced much American folklore into his poetry. In his long free-verse poem *The People, Yes* (1936), he included tall tales about such characters as Paul Bunyan and Christopher Columbus. Sandburg ended the poem with the American people vigorously on the march, seeking new forms of self-expression, and asking the questions, "Where to? What next?"

Sandburg believed deeply in the value of life, and he strongly opposed war. In his dramatic short poems "Grass" (1918) and "A.E.F." (1920), Sandburg protested against the folly and waste of war.

Some critics consider Sandburg's poetry crude and sentimental. But most critics agree that he accomplished his goal of being the voice of the American people and a spokesman for American democracy. His *Complete Poems* (1950) won the 1951 Pulitzer Prize for poetry.

His prose. To Sandburg, Abraham Lincoln represented the best in the American character. Sandburg regarded the Civil War as the most important event in American history. From 1920 to 1939, he wrote six volumes of history about Lincoln and the war. In *Abraham Lincoln: The Prairie Years* (two volumes, 1926), Sandburg dealt with Lincoln's career up to his election as president. Then, in *Abraham Lincoln: The War Years* (four volumes, 1939), Sandburg provided one of the fullest accounts of Lincoln's presidency ever written. For this work, Sandburg received the 1940 Pulitzer Prize for history.

Sandburg wrote three volumes of humorous stories for children—*Rootabaga Stories* (1922), *Rootabaga Pigeons* (1923), and *Potato Face* (1930). He also wrote a historical novel, *Remembrance Rock* (1948). Clark Griffith

See also **Slang.**

Additional resources

Meltzer, Milton. *Carl Sandburg.* Millbrook, 1999. Younger readers.

Niven, Penelope. *Carl Sandburg.* 1991. Reprint. Univ. of Ill. Pr., 1994.

Sande, Earl (1898-1968), was an American jockey. He won 967 races and rode Kentucky Derby winners in 1923, 1925, and 1930. He retired as a jockey in 1932 and became a horse trainer. He was a quarter-mile rider and broncobuster before becoming a jockey in 1918. Sande was elected to racing's Hall of Fame in 1955. He was born on Nov. 13, 1898, in Groton, South Dakota.

William F. Reed

Sanderling is a bird that belongs to the same family as snipes and sandpipers. It differs from these birds in that it has only three toes. Sanderlings breed on Arctic beaches and tundra, and travel south in the winter. They appear then from California and Texas to northern South America. They also appear on many Pacific islands.

The bird is about 8 inches (20 centimeters) long. Its feathers are hoary-gray on the upper parts and pure white beneath. The sanderling usually lives on seashores. Its favorite foods are small shellfish and marine insects that wash up with the tide. The female lays three or four eggs colored a brownish-olive. Sanderling eggs are speckled with darker markings. Fritz L. Knopf

Scientific classification. The sanderling belongs to the family Scolopacidae. Its scientific name is *Calidris alba.*

Sanders, Barry (1968-), ranks among the greatest running backs in football history. Sanders combined speed, strength, and an ability to make quick changes of direction in his runs. He was also a durable player, though he was relatively small for a running back at 5 feet 8 inches (173 centimeters) tall and weighing about 200 pounds (91 kilograms).

Sanders was born on July 16, 1968, in Wichita, Kansas. He attended Oklahoma State University from 1986 to 1989, winning All-American honors and earning the 1988 Heisman Trophy as the best college player of the year. He was drafted by the Detroit Lions of the National Football League (NFL) in 1989 and was named Rookie of the Year. He played his entire professional career with Detroit. By the end of the 1997 season, Sanders had broken several rushing records. Sanders was awarded the

Jim Thorpe Trophy as the NFL's Most Valuable Player in 1997. In 1999, he announced his retirement from football. Sanders ended his career with 15,269 rushing yards. Only Walter Payton and Emmitt Smith rushed for more yards. Dave Nightingale

Sanders, Deion, *DEE ahn* (1967-), is one of the few athletes in American sports to have starred in two professional sports. As a football player, Sanders was an All-America defensive back in college and a star defensive player, kick return specialist, and wide receiver in the National Football League (NFL). As a major league baseball player, Sanders was known for his speed as a base stealer and as an outfielder. He became famous for his flashy playing style in both sports and for his exuberant personality. He has been nicknamed "Neon Deion" and "Prime Time." Sanders retired from the NFL in 2001.

Deion Luwynn Sanders was born on Aug. 9, 1967, in Fort Myers, Florida. He played football at Florida State University, winning All-America honors in 1987 and 1988. Sanders played baseball with the New York Yankees in 1989 and then played football with the Atlanta Falcons the same year. As a baseball player, Sanders has played with the Yankees, the Atlanta Braves, the Cincinnati Reds, and the San Francisco Giants. As a football player, he played for Atlanta, the San Francisco 49ers, the Dallas Cowboys, and the Washington Redskins. He is the only athlete to play in both a World Series (1992 with Atlanta) and two Super Bowls (1995 with San Francisco and 1996 with Dallas). Dave Nightingale

Sandgrouse is the name of a group of birds from Africa, Asia, and parts of Europe. Many species of sandgrouse live in arid and semiarid regions that include some of the world's harshest desert habitats.

Sandgrouse resemble partridges and pigeons. However, many scientists believe they are most closely related to shorebirds. Sandgrouse usually range from 10 to 16 inches (25 to 41 centimeters) long. They have small heads, short bills, relatively long pointed wings, and short legs often feathered down to the feet. Many species are brownish in color with barred, spotted, or streaked patterns.

Sandgrouse live in family groups, but they commonly gather in huge flocks. Such flocks normally congregate at watering holes each morning or evening. The birds build their nests on the ground. An adult male sandgrouse can carry water to his young in his breast feathers. The chicks then drink the water from his feathers. Sandgrouse feathers hold moisture like a sponge, enabling the birds to nest in dry areas far from water. Their dense plumage also acts as insulation, keeping the birds cool on hot days and warm during cool nights. A sandgrouse's diet consists mostly of seeds. Donald F. Bruning

Scientific classification. Sandgrouse belong to the sandgrouse family, Pteroclidae.

Sandhill crane. See Crane (with picture).

Sandia National Laboratories is one of the largest centers in the United States for the development of nuclear weapons systems. It is headquartered in Albuquerque, New Mexico. Sandia researches, engineers, and produces all *components* (parts) of nuclear weapons systems except the explosives. Sandia works closely with Lawrence Livermore and Los Alamos National Laboratories, which develop the nuclear explosives for the nation's weapons systems.

Sandia technicians design and produce a wide variety of devices that control a nuclear weapon's operation. These devices include arming and firing systems that consist of extremely tiny, *microelectronic* components. Sandia also produces safety systems that prevent weapons from exploding accidentally and ones that prevent unauthorized individuals from using the weapons. It also conducts research in materials science, alternative energy systems, waste management, and other fields.

Sandia was founded in 1945 as a branch of the Los Alamos National Laboratory. Today, AT&T Corp. operates Sandia for the United States Department of Energy. Toni Grayson Joseph

Sandinistas. See Nicaragua (Rebel victory).

Sandino, *sahn DEE noh*, Augusto César, *ow GOOS toh SAY sahr* (1895-1934), was a Nicaraguan revolutionary. Sandino led a guerrilla struggle from 1927 to 1933 against the occupation of his country by United States Marines. The Sandinista National Liberation Front, which ruled Nicaragua from 1979 to 1990, was named for him.

Sandino was born in Niquinohomo, Nicaragua. In 1926, U.S. Marines invaded Nicaragua to stop a rebellion by Nicaragua's Liberal Party against the country's conservative government. Sandino fought for the Liberals. In 1927, Liberal leaders reached a settlement with the United States. But Sandino was angered by the agreement and began fighting a guerrilla war to expel the Marines from Nicaragua. Sandino's forces, which consisted of hundreds of peasants and miners, effectively fought and eluded the Marines and the Nicaraguan National Guard. The Marines withdrew from Nicaragua in 1933. In 1934, Sandino was assassinated at the order of General Anastasio Somoza García, head of the National Guard. Somoza later became dictator of Nicaragua. John A. Booth

Sandpiper is a name given to a large number of birds. But the name usually refers to certain types of small birds with long, sensitive bills. These birds live on the seashore in all parts of the world, and many species build their nests north of the Arctic Circle.

The plumage of sandpipers varies from buff to brown, gray, white, or black. The birds dig in soft mud or sand, or probe among rocks, in search of insects, worms, shrimps, and soft mollusks. Sandpipers often follow receding waves, sometimes in flocks, searching for bits of food. Their graceful movements and cheerful cries have made them popular birds. The female sandpiper lays three to four eggs. Sandpiper eggs are colored a light gray, buff, or olive, and spotted with dark brown.

One of the best-known North American species is the *spotted sandpiper,* which is found throughout the United States and southern Canada. The *upland sandpiper* is a useful bird that eats insects. It lives on dry uplands in the United States and Canada. Hunters once killed upland sandpipers in great numbers. A larger sandpiper species called the *willet* lives in marshes along the warm Atlantic and Gulf coasts, and in many western states. Laws protect all sandpipers from hunters. George L. Hunt, Jr.

Scientific classification. Sandpipers belong to the family Scolopacidae. The scientific name for the spotted sandpiper is *Actitis macularia,* the upland sandpiper is *Bartramia longicauda,* and the willet is *Catoptrophorus semipalmatus.*

See also **Bird** (pictures); **Ruff**; **Snipe**; **Upland sandpiper**; **Willet**.

Sandstone is a type of rock made chiefly of sand that has been "cemented" by pressure or by minerals. The sand commonly consists of grains of quartz, feldspar, and other minerals. It may also include organic matter or rock fragments. The minerals that cement the grains include quartz, pyrite, or calcite. The color of sandstone ranges from cream or gray to red, brown, or green, depending on the cements and impurities in the sand.

Brownstone, a reddish-brown sandstone, was once widely used to build houses in the eastern United States. Sandstone was a common building material for larger structures before reinforced concrete came into use in the middle to late 1800's. Some great cathedrals in Europe were built of sandstone. Finley C. Bishop

See also **Building stone; Quarrying; Sedimentary rock.**

Sandstorm is a wind storm that carries sand through the air. The wind-driven sand forms a low cloud near the ground. Most of the sand particles do not rise higher than 10 feet (3 meters), but some grains rise up to 50 feet (15 meters). The grains average from $\frac{1}{170}$ to $\frac{1}{85}$ inch (0.15 to 0.30 millimeter) in diameter. During sandstorms, wind speeds exceed 10 miles (16 kilometers) per hour. The storms may last three to five hours. They tend to form during the day and die out at night.

Most sandstorms occur in the sandy areas of deserts. Some occur on beaches; dry riverbeds; or deposits of gravel, sand, and silt called *alluvial fans.* Sandstorms reduce visibility and thus endanger motorists on desert roads. They also damage crops. In the United States, a sandstorm is reported when blowing sand reduces visibility below $\frac{5}{8}$ mile (1 kilometer).

During a sandstorm, most of the sand moves by a jumping or bouncing motion called *saltation.* When the wind gains speed, grains of sand roll forward and collide with other grains, causing many of them to bounce upward. Some of these grains fall and then bounce up again after striking a pebble or rock. Richard A. Dirks

See also **Dust storm.**

Sandwich. See **Food** (table: Interesting facts).

Sanford, Maria L. (1836-1920), was one of the first woman professors in the United States. She taught at the University of Minnesota for 30 years. She was a leading educator of African Americans, Indians, and exceptional students. A statue of Sanford stands in the U.S. Capitol in Washington, D.C. She was born in Saybrook, Connecticut.

Sanger, Frederick (1918-), a British biochemist, won the 1958 and 1980 Nobel Prizes in chemistry. He became the second person to receive two Nobel Prizes in the same field. The first was John Bardeen, who earned two Nobel Prizes in physics.

Sanger received the 1958 chemistry prize for developing a method of studying the structure of proteins. His research centered on the structure of insulin, the protein hormone that helps the body use sugar. Sanger shared the 1980 prize with Americans Paul Berg and Walter Gilbert. The three were honored for their studies concerning the biochemistry of nucleic acids. Sanger was cited for developing a method of determining the chemical structure of large pieces of *deoxyribonucleic acid* (DNA), the substance that makes up genes.

Sanger was born in Gloucestershire, England. He did his research at Cambridge University. Trevor H. Levere

Sanger, Margaret (1883-1966), was an American leader of the birth control movement in the early 1900's. At that time, it was illegal to distribute birth control information or devices in the United States. Sanger believed women should have economic and social equality with men. She thought that, to achieve such equality, women needed to avoid unwanted pregnancy. To help them do so, she founded what became the Planned Parenthood Federation of America, the nation's major birth control organization. Sanger originated the term *birth control,* which was formerly called *voluntary motherhood.*

The Sophia Smith Collection, Smith College

Margaret Sanger

Sanger was born in Corning, New York. In 1912, she began to work as a nurse, caring for poor women in New York City. She saw the suffering caused to women by unwanted pregnancy. She joined the Socialist Party, became a feminist, and devoted her life to promoting birth control. In 1916, Sanger opened a birth control clinic, for which she was arrested and sent to prison. She eventually helped obtain passage of laws allowing doctors to give birth control advice. Linda Gordon

See also **Birth control** (The birth control movement); **Planned Parenthood Federation of America.**

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Chesler, Ellen. *Woman of Valor: Margaret Sanger and the Birth Control Movement in America.* 1992. Reprint. Doubleday, 1993.

Whitelaw, Nancy. *Margaret Sanger: "Every Child a Wanted Child."* Dillon Pr., 1994.

Sangster, Charles (1822-1893), was a Canadian poet. His best poems sensitively describe the Canadian landscape and reflect his passionate sympathy for nature. His work shows the influence of the British Romantic poets, especially Lord Byron and Sir Walter Scott.

Sangster was born in Kingston, Upper Canada (in present-day Ontario). He left school at the age of 15 to work in a Kingston ammunition factory. Sangster worked as a newspaper reporter and editor from 1849 to 1868. He was a self-taught poet, writing during his spare time. In 1868, he settled in Ottawa, where he worked in the Canadian post office department until 1886. Sangster's poetry was published in *The St. Lawrence and the Saguenay, and Other Poems* (1856) and *Hesperus, and Other Poems and Lyrics* (1860).

Rosemary Sullivan

Sanhedrin, *SAN hih drihn,* was the highest national governing council of the Jews in Roman times. Some scholars believe there were two Sanhedrins. The 23 members of the political and civil Sanhedrin came mostly from among the Sadducees. The 70 members of the religious Sanhedrin, which was led by the high priest, came largely from among the Pharisees. According to the Christian Bible in Matthew 26:57 and John 11:47, Jesus was tried before the religious Sanhedrin. Saints

Peter, John, Stephen, and Paul appeared before it on charges of religious error. After Rome put down a Jewish revolt in Palestine in A.D. 70, the council declined and completely disappeared. See also Gamaliel.

Gary G. Porton

Sanitarium, *SAN uh TAIR ee um,* is a place where people go to improve their health. The word is sometimes used as another word for *sanatorium.*

A *sanatorium* is an establishment where sick people are treated. It is especially used for a place where a particular treatment is given. Edward J. Shahady

Sanitation is a field of public health. It involves various efforts to control the environment to prevent and control disease. Sanitation activities include food processing and distribution, sewage treatment, solid waste disposal, water treatment, and numerous other measures, such as control of air pollution and rodents. Sanitation also includes personal cleanliness, which helps protect against disease.

Many professions and various government agencies work together to protect the health of communities. Environmental engineers design and administer water treatment plants, sewage treatment plants, and solid-waste disposal facilities. Government agencies establish and enforce laws that help promote a healthful environment.

Food processing and distribution. Food and beverages can easily be contaminated by bacteria, viruses, worms, and other organisms and by chemical poisons. Government agencies are usually involved in food and beverage control. For example, the United States Department of Agriculture inspects meat before and after animals are slaughtered. It also checks the processing, labeling, packaging, and distribution of food. The U.S. Public Health Service provides communities with model laws that recommend requirements for producing, processing, and handling food. See **Pure food and drug laws** (Foods); **Meat packing** (U.S. government inspection).

Sewage treatment. Sewage is water containing waste matter produced by people. It contains about a tenth of 1 percent solid waste. It comes from sinks and toilets in homes, farms, restaurants, factories, and office buildings. Much industrial sewage contains harmful chemicals and other waste materials.

Sewage must be treated before it flows from sewerage systems into lakes, rivers, and other bodies of water. Untreated sewage contaminates the water and, in time, can kill fish and aquatic plants. The sewage makes the water unsafe to drink and can also prevent use of the water for swimming, fishing, and other recreation.

Most cities and towns have at least one sewage treatment plant. In most rural areas, homeowners must provide their own sewage treatment. Most do so with large underground containers called *septic tanks.* For more information on sewage treatment, see **Sewage.**

Solid waste disposal has become a major sanitation problem. Solid waste, which is also called *refuse,* consists of garbage and trash from cities and towns, plus by-products of farming, mining, and manufacturing. Such by-products include animal carcasses and manure from farms, sawdust and scrap metal from factories, and pieces of coal and various metals from mines.

Almost all methods of solid waste disposal can create environmental problems. For example, open dumps look unpleasant and may be foul smelling. They also provide homes for rats and other animals that carry disease. Burning solid waste causes smoke, which pollutes the air. But when land disposal sites and incinerators are properly operated, they cause little harm to the environment. See **Waste disposal.**

Water treatment. Most water must be treated before it is used for drinking, cooking, bathing, or laundering. Almost all untreated water contains bacteria, viruses, and other tiny organisms. It also may have an unpleasant odor and taste and contain minerals that make the water less useful as a cleaning agent.

Cities and towns obtain water from one of two sources: (1) the ground or (2) rivers and lakes. Many small communities get their water from the ground. Such water requires little treatment. Most large cities get their water from rivers and lakes for various reasons. In many cities, for example, there is not enough water in the ground to supply the large population. Water from rivers and lakes is piped from its source to a treatment plant, where chemical and physical processes purify it. Pipes under the streets distribute the water to houses and other buildings.

Other sanitation activities. Most communities have regulations that require dwellings, factories, hospitals, and recreation areas to meet certain sanitary standards. Sanitation also includes insect and rodent control, noise control, and licensing of operators of public facilities.

Melody J. Hunt

See also **Environmental pollution; Public health; Water** (City water systems).

Sanskrit language is the oldest formal written language of India and the basis of many modern Indian languages, including Hindi and Urdu. Its earliest dialect form, Vedic, was spoken by the Aryans, a people who invaded India from central Asia about 1500 B.C.

Sanskrit died out as a living language by about 100 B.C. However, Sanskrit continued, like Latin in the West, as a language of courtly poetry and drama. It also served as the learned language for science, philosophy, and religious texts. Even today, some scholars in India teach, speak, and write in Sanskrit.

The name *Sanskrit* means *refined* or *polished.* The term contrasts with the designation *Prakrit,* meaning *common* or *vulgar,* which is applied to the popular languages that developed from Sanskrit over a period of several hundred years. These languages, in turn, are the source of such modern languages of India as Bengali, Hindi, and Punjabi.

Sanskrit contains a rich selection of sounds. The language has 10 simple vowels and 4 *diphthongs* (paired vowel sounds pronounced as a single syllable). It also has 25 basic consonants, 4 *semivowels* (letters, such as *y,* that sound like vowels but take the place of con-

[a] काकौ वृक्षे वसतः [b] देवो वदति
[c] किमर्थम्पितरम्पुत्रो न स्मरति

Sanskrit is the classical language of Hindu religion and culture. Translated, these Sanskrit sentences mean: (a) Two crows dwell in a tree; (b) The God speaks; (c) Why does the son not remember the father?

sonants), and 3 *sibilants,* which produce hissing sounds. In addition, it has two breathing sounds, and a nasalizing sound. Sanskrit has a complex grammar. For example, nouns and adjectives have three genders (masculine, feminine, and neuter). They are inflected for three grammatical numbers (singular, dual, and plural). They also have eight cases (nominative, accusative, instrumental, dative, ablative, genitive, locative, and vocative). The verbal system is equally complex. Sanskrit belongs to the Indo-Iranian branch of the Indo-European language family. Stanley Insler

See also Sanskrit literature; **India** (Languages); **Aryans.**

Sanskrit literature is the literature of India written in the ancient language called Sanskrit. The literature falls into three periods—Vedic, Epic, and Classical.

The Vedic period extended from about 1400 to 500 B.C. Vedic literature is essentially religious and concerns the solemn and domestic rituals of the early Aryan civilization of India. The oldest of these works are three related Vedas—*Rigveda, Samaveda,* and *Yajurveda.* A fourth Veda is called the *Atharvaveda.* The Vedas are anthologies of texts in verse that provided the liturgies for the holiest rites of the early Indian religion. Attached to the Vedas are later texts, including the *Brahmanas* and the *Upanishads.* The *Brahmanas* are long prose works that explain the mythological and theological significance of these rites. The *Upanishads* emphasize inward reflection and search for unity in existence. The Upanishads gave birth to the development of Indian philosophy. See **Vedas; Upanishads.**

As the Vedic period ended, the old religion was threatened by new religious movements. A vast body of literature arose to preserve the ancient texts and rituals in unchanged form. This literature included manuals for ritual performance and books on such subjects as grammar, astronomy, and mathematics. These texts reflect the full development of the scientific method in ancient India.

The Epic period overlapped the Vedic and Classical periods and covered the years of composition of India's two great epic poems, the *Mahabharata* and the *Ramayana.* Both were probably begun in about 500 B.C. or earlier. Since then they have grown in size and form. The most famous section of the *Mahabharata* is a philosophical dialogue called the *Bhagavad-Gita.* See **Bhagavad-Gita; Mahabharata; Ramayana.**

The Classical period begins with the grammarian Panini in the 400's B.C. Panini described the Sanskrit he spoke in a set of about 4,000 rules. His grammar became the basis for all Sanskrit usage by later cultured writers. The oldest surviving works in Classical Sanskrit are the plays and poems of the Buddhist author Asvaghosa, who lived about A.D. 100, and the plays of Bhasa, who lived about A.D. 300.

The finest writer in the Classical style was Kalidasa, a poet during the Gupta dynasty, which reigned from about 320 to 500. His refined and elegant Sanskrit works remained unsurpassed. Kalidasa's talent is best seen in the lyric poem *The Cloud Messenger.* He also composed dramas and epic poems. The first Sanskrit novel was *The Tale of the Ten Princes* by Dandin, who may have lived in the 600's. Stanley Insler

See also **Drama** (Asian drama); **Gupta dynasty** (Cultural life under the Guptas); **Hindi; Hinduism** (Sacred writings); **Sanskrit language.**

Santa Ana, *SAHN tah AH nah* (pop. 135,186), is the second largest city in El Salvador. Only San Salvador has more people. Santa Ana is an important commercial center, especially for the production of coffee and sugar. Other important industrial activities in Santa Ana include brewing and the manufacture of cotton textiles, footwear, and furniture. Santa Ana also has a national theater and an art school. For location, see **El Salvador** (political map). Gary S. Elbow

Santa Anna, *SAHN tah AH nah,* **Antonio López de** (1795-1876), was a Mexican soldier and politician. He was president of Mexico 11 times and often ruled as a dictator, but he was always overthrown.

Young soldier. Santa Anna was born in Jalapa, in the province of Veracruz. At the age of 15, he became a cadet in the Spanish Army stationed in Mexico. He began his long career by fighting for Spain against the Mexicans when the Mexicans started their armed struggle for independence in 1810.

During the War of Independence of 1821, he deserted the Spaniards and joined forces with Mexican leader Agustín de Iturbide. Mexico won its freedom from Spain in 1821, and Iturbide became emperor. See **Iturbide, Agustín de.**

Santa Anna expected the new emperor to make him governor of Veracruz. When Iturbide failed to do so, Santa Anna led a revolt against him and drove him from power. In 1829, Spain attempted to reconquer Mexico. Santa Anna, as commander in chief of the Mexican Army, won several victories, and the Spanish invasion was defeated. He was elected president in 1833 but did not serve. In 1834, he joined a revolt against the acting

Oil portrait (about 1858) by Paul L'Ouvrier. The New-York Historical Society, New York City

Santa Anna, a Mexican general, ruled Mexico as president 11 times during the 1800's but was overthrown each time. In 1836, he defeated Texan troops in the famous Battle of the Alamo at San Antonio.

government, took control of the country, and assumed dictatorial powers.

War with Texas. In 1835, Texas, which was then a part of Mexico, revolted against the Mexican government. The population of Texas included many settlers from the United States, and cultural and legal differences between Mexicans and the settlers had led numerous Texans to oppose Mexican rule.

Santa Anna rushed north to put down the revolt. He attacked San Antonio and stormed the Alamo in March 1836, with an army that greatly outnumbered the Texans (see **Alamo**). Santa Anna's troops captured the Alamo, and then met the main Texas army under General Sam Houston at San Jacinto. Santa Anna's army was routed, and he was taken prisoner. The Texans forced Santa Anna to sign a treaty acknowledging the independence of Texas. But the treaty was rejected in Mexico City, and Santa Anna was removed from power.

The American war. In 1838, the French attacked Veracruz. Santa Anna took command of the defending troops and beat back the attackers. From 1841 to 1844, he was president of Mexico again. In 1844, there was a revolt against him, and he fled to Jamaica. War broke out with the United States in 1846. Santa Anna returned to Mexico and took command of the army. The American forces defeated him at Buena Vista, at Cerro Gordo, and at Chapultepec. After the fall of Mexico City, Santa Anna left Mexico for several years.

In 1853, he returned to Mexico and became president again. He declared himself president for life but within two years was again overthrown and exiled. He tried to return during the French invasion of Mexico in 1864 but was not allowed to enter the country. He returned in 1874 after the death of President Benito Juárez and died in poverty in Mexico City. W. Dirk Raat

See also **Mexican War.**

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Santa Barbara (pop. 92,325) is an old Spanish mission town in southern California. It lies on the Pacific Coast, at the foot of the Santa Ynez Mountains (see **California** [political map]). The city is the seat of Santa Barbara County. Santa Barbara and nearby Santa Maria and Lompoc form a metropolitan area with 399,347 people.

Santa Barbara celebrates its Spanish background. Its mission is known as the "Queen of the California Missions" because of its architectural beauty. Many visitors come during the Old Spanish Days Fiesta held every August. Tourism is the chief economic activity. Westmont College and a large campus of the University of California are near Santa Barbara. Vandenberg Air Force Base lies northwest of the city.

Father Junípero Serra and Captain José Francisco de Ortega founded the city as a Spanish *presidio* (military fort) in 1782. The mission was founded in 1786. Santa Barbara became an incorporated city in 1850. It has a council-manager government. James J. Rawls

Santa Claus is a legendary old man who brings gifts to children at Christmas. He has long been portrayed as a stout, bearded man in a red, fur-trimmed suit. The legend of Santa Claus is popular mainly in the United States.

Drawing (1879) by Thomas Nast from *Harper's Weekly* (The Newberry Library, Chicago)

Santa Claus was popularized as a jolly fat man driving a sleigh in a series of drawings by the American cartoonist Thomas Nast.

The idea of Santa Claus developed from stories about a real person named Saint Nicholas. Historians know little for certain about him. He was probably born in Patara, in what is now Turkey. When he was 19 years old, Nicholas became a priest. He later served as bishop of Myra, near Patara. He died during the A.D. 300's.

According to legend, Saint Nicholas once aided a poor nobleman who had three daughters. No men would marry the daughters because the nobleman did not provide any of them with a *dowry.* A dowry is money or property that the bride's family gives the bride or the groom or his family when the couple marry. Saint Nicholas threw three bags of money through an open window of the nobleman's house to show that the daughters now had dowries. As a result, they were able to marry. The legend of Saint Nicholas as a man who brings gifts may have developed from this story.

How the Santa Claus legend began. The custom of giving gifts on a special day in winter was practiced before Christianity was founded. After Christianity was well established, Saint Nicholas became a symbol of the custom among Christians. During the Reformation of the 1500's, Protestants substituted nonreligious characters for Saint Nicholas. In England, for example, the saint was replaced by a gentleman called *Father Christmas.* This character was called *Père Noël* in France and *Weihnachtsmann* in Germany.

The people of the Netherlands were especially fond of Saint Nicholas. The first Dutch settlers who came to America had a figure of Saint Nicholas on the front of

their ship. The Dutch settlers maintained their custom of celebrating the saint's feast day on December 6. They told their children that the saint visited their homes and left gifts on Saint Nicholas Eve. In time, English settlers adopted the legends and festivities associated with Saint Nicholas. English-speaking children spoke the Dutch name for the saint, *Sinterklaas,* quickly and excitedly so that it sounded like *Santy Claus* or *Santa Claus.*

Santa's appearance. Until the 1800's, people pictured Saint Nicholas as a tall, thin, stately man who wore a bishop's robe and rode a white horse. In 1809, the American author Washington Irving published *Knickerbocker's History of New York,* in which he presented a new version of the saint. Irving described Saint Nicholas as a stout, jolly man who wore a broad-brimmed hat and huge breeches and smoked a long pipe. Irving's Saint Nicholas rode over treetops in a wagon and filled children's stockings with presents.

On Dec. 23, 1823, a poem entitled "An Account of a Visit from St. Nicholas" appeared in the *Troy* (New York) *Sentinel.* This poem begins with the familiar line "'Twas the night before Christmas." Clement Clarke Moore, an American scholar, is generally credited with writing the poem, but Henry Livingston, an American land surveyor, may have written it. In the poem, Saint Nicholas appears as a stout, jolly man with twinkling eyes and a red nose. He wears a suit trimmed with white fur and rides a sleigh pulled by eight reindeer. The saint's visit takes place on Christmas Eve. See **Moore, Clement Clarke.**

Thomas Nast, an American cartoonist, completed the present-day image of Santa Claus. Nast created a series of drawings for *Harper's Weekly* magazine between 1863 and 1886. These drawings represent Santa Claus with a white beard. In various cartoons, Santa is shown working in his shop, driving a sleigh pulled by reindeer, or placing toys in stockings hung over a fireplace.

© Ellis Herwig from Marilyn Gartman

Santa Claus has traditionally been portrayed as a stout, jolly man with a white beard and wearing a red suit with white fur.

Santalike characters in other countries. Today, people in many parts of the world are familiar with the legend of Santa Claus. But he is primarily an American tradition. People in most countries have adopted other imaginary characters who supposedly bring gifts on a certain day of the year other than Christmas.

In the Netherlands and Belgium, Saint Nicholas visits homes on St. Nicholas Eve, December 5. He leaves small gifts in shoes that the children put near the fireplace, to be opened on St. Nicholas Day, December 6. He often is accompanied by a character named Black Pete, who carries a birch rod to whip naughty children. People in Austria, Hungary, and Germany also celebrate this holiday.

In southern Germany, people usually say the *Christkind* (Christ child) sends the gifts on Christmas Eve. But in northern Germany, most people say the *Weihnachtsmann* (Christmas Man) brings the presents. From the name Christkind came the character *Kris Kringle,* who gradually became identified with Santa Claus. In France, Père Noël leaves small presents in homes on Christmas Eve. In Sweden, the *Jultomten,* an elflike character, brings gifts on Christmas Eve. This elf is called *Julenissen* in Denmark and Norway. Robert J. Myers

See also **Christmas** (with pictures); **Nicholas, Saint.**

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Santa Claus, Indiana (pop. 2,041), is best known for its postmark. The town is located in southern Indiana, 35 miles (55 kilometers) east of Evansville. According to legend, a group of settlers named the town Santa Claus on Christmas Eve in 1852. Every December, thousands of letters addressed to "Dear Santa Claus" pour into this town. In a typical December, about 500,000 pieces of mail come from many parts of the world to be remailed with the famous postmark. The town also has a Holiday World amusement park with a Santa Claus Land section. See also **Indiana** (Places to visit). Thomas Guengerich

Santa Fe, *SAN tuh FAY* (pop. 441,982), is a commercial and shipping center in east-central Argentina. It lies on the west bank of the Paraná River at the mouth of the Salado River (see **Argentina** [political map]). The city is the capital of the province of Santa Fe.

Santa Fe has several churches and convents dating from the 1600's, when it was a Jesuit missionary center. A tunnel under the Paraná River links Santa Fe with the city of Paraná. At Santa Fe's large docks, oceangoing ships load with such exports as copper, dairy products, flour, grain, leather, and zinc. The National University of the Litoral is in Santa Fe. Settlers from Asunción, in what is now Paraguay, founded Santa Fe near its present site in 1573. But the present site was not permanently occupied until 1651. Richard W. Wilkie

Santa Fe, *SAN tuh FAY,* New Mexico (pop. 62,203; met. area pop. 147,635), is the state capital and a major tour-

ist center of the Southwest. The charm of the city's adobe houses and narrow, winding streets helps attract many visitors. Santa Fe has been a seat of government longer than any other state capital. It was founded in 1609 or 1610 as the capital of the Spanish colony of New Mexico. The city is in north-central New Mexico, about 7,000 feet (2,100 meters) above sea level in the foothills of the Sangre de Cristo Range of the Rockies (see New Mexico [political map]). It is the nation's highest state capital.

Federal, state, and city government agencies and the tourism industry are Santa Fe's chief employers. The city is the home of the College of Santa Fe, St. John's College, and Santa Fe Community College. The Museum of New Mexico administers several museums in Santa Fe, including the Museum of Fine Arts, the Museum of Indian Arts and Culture, the Museum of International Folk Art, and the Palace of the Governors. Other museums include the Museum of Spanish Colonial Art, the Sante Fe Children's Museum, and the Georgia O'Keeffe Museum, which has the world's largest permanent collection of O'Keeffe's works. The Santa Fe Opera and the Sante Fe Chamber Music Festival offer many summer events.

Pueblo Indians lived in what is now the Santa Fe area before Spanish colonists arrived in the region in 1598. Pueblo Indians still live nearby in ancient villages. The Spanish colonists named the city *La Villa Real de la Santa Fe,* which means *The Royal City of the Holy Faith.* During the 1800's, Santa Fe was the western terminal of the Santa Fe Trail. In 1821, Mexico gained independence from Spain, and Santa Fe became the capital of a Mexican province. New Mexico became a United States territory in 1850. It became a state in 1912, with Santa Fe as the capital. The city has a mayor-council form of government and is the seat of Santa Fe County. Jon Hunner

See also New Mexico (pictures); Santa Fe Trail.

Santa Fe Trail, *SAN tuh FAY,* was one of the longest commercial routes in the United States in the prerailroad era. It began in Independence, Missouri, and ended in Santa Fe, New Mexico, a distance of 780 miles (1,260 kilometers). Caravans of traders traveled to Council Grove, Kansas, and on to a point on the Arkansas River near Cimarron, Kansas. There the route divided. One branch led up the Arkansas to Bent's Fort (near La Junta, Colorado), then turned southwest across Raton Pass to the upper Canadian River in New Mexico. The other route, called the Cimarron Crossing, cut across a wide, dry plain.

The early travelers transported their goods by pack horses. William Becknell opened the Santa Fe Trail in 1821. After that, traders took wagons loaded with manufactured goods to Santa Fe to exchange for burros, furs, gold, horses, and silver. Between 1822 and 1843, an average of about 80 wagons and 150 people used the trail each year. Travel westward increased greatly in the 1850's and 1860's. By the late 1860's, more than 5,000 wagons a year used the trail. An extension of the trail, known as *The Old Spanish Trail,* ran from Santa Fe to Los Angeles by way of Durango, Colorado, the Green and Virgin rivers in Utah, the Colorado River, and across the Mojave Desert in California. Dan L. Flores

See also Westward movement in America (The Santa Fe Trail).

Santa María. See Columbus, Christopher (First voyage westward); Caravel.

Santa Marta, *SAN tuh MAHR tuh* (pop. 313,072), is a seaport near the northern tip of Colombia. For location, see Colombia (map). The city is a popular seaside resort and an important banana-shipping center. El Cerrejon, in the Santa Marta area, is one of the largest open-pit coal mines in the world. Many years ago, the city was the point from which adventurers started in search of El Dorado (see El Dorado). Santa Marta was founded in 1525 by Rodrigo de Bastidas, a Spanish navigator and explorer. It is the oldest permanent settlement in South America. Jerry R. Williams

Santayana, *SAHN tah YAH nah* or *SAN tee AN uh,* **George** (1863-1952), was a philosopher and author. He was born in Spain but grew up in the United States and spent about half his life there. He expressed his philosophy in technical works as well as in dialogues, literary essays, sonnets, and a novel, *The Last Puritan* (1936).

Santayana's philosophy puzzles many readers. He developed a theory of reality that centered on the distinction between *essences* and *existence.* Santayana defined essences as ideas, meanings, perceptions, and possibilities. In contrast, the world of existence includes the events, people, and things that we encounter in life. Santayana believed that not all essences actually exist, but that every existing thing includes essences. The role of essences, according to Santayana, is to describe and illuminate existence.

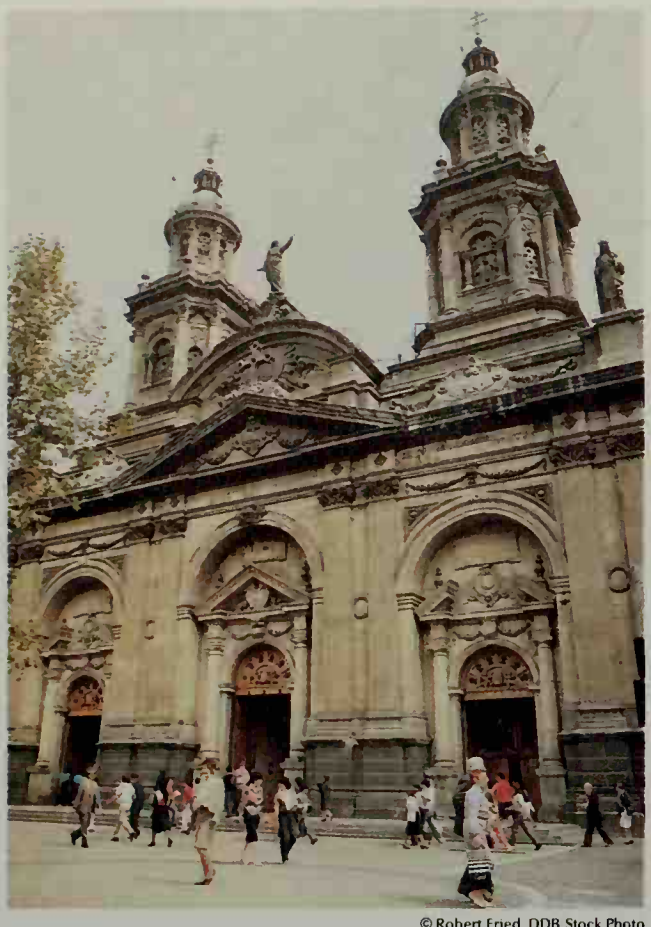
Santayana regarded religion as a kind of poetry expressing imaginative ideals that give spiritual meaning to life. But he said religion must not be taken literally. He wrote that people must believe in an ideal world where the human spirit can be creative and free. But this ideal world must not be mistaken for reality.

Santayana wrote an enormous number of works on art, morality, religion, and science. His *Three Philosophical Poets* (1910) consists of interpretations of Dante Alighieri, Lucretius, and Johann Wolfgang von Goethe. His *Character and Opinion in the United States* (1920) is a commentary on American life. Santayana's other well-known books include *The Sense of Beauty* (1896), *Interpretations of Religion and Poetry* (1900), *The Life of Reason* (five volumes, 1905-1906), *Scepticism and Animal Faith* (1923), and *Realms of Being* (four volumes, 1927-1940). *Persons and Places: Fragments of Autobiography* was published in 1987, after his death.

Santayana was born on Dec. 16, 1863, in Madrid. His family moved to the United States in 1872 and settled in Boston. Santayana graduated from Harvard University. He taught philosophy at Harvard from 1889 to 1912, when he settled permanently in Europe. John E. Smith

Santiago, *SAN tee AH goh* (pop. 4,385,481), is the capital and largest city of Chile. It is also the country's cultural, economic, and transportation center. Santiago lies in the center of Chile, about 90 miles (145 kilometers) east of the Pacific Ocean (see Chile [political map]). Chile's president and Supreme Court are based in Santiago, but the legislature meets in Valparaíso, a port city to the west. About one-third of all Chileans live in Santiago.

The city lies in the fertile Central Valley, the agricultural heartland of Chile. The Santiago metropolitan area covers 814 square miles (2,109 square kilometers). The Andes Mountains rise above Santiago to the east. Many of these peaks remain snow-capped the year around. To the west is the Coastal Range along the Pacific. The



© Robert Fried, DDB Stock Photo

Santiago, Chile, has many attractive buildings. The Cathedral of Santiago dates from 1780. It stands next to the Plaza de Armas in the heart of downtown Santiago.

Mapocho River runs east to west through the city.

Several hills dominate the city's landscape. Cerro Santa Lucía (Santa Lucía Hill) rises 230 feet (70 meters) in the downtown area and is a beautifully landscaped park with statues, gardens, and fountains. The 985-foot (300-meter) Cerro San Cristóbal (San Cristóbal Hill), another Santiago park, has a statue of the Virgin Mary at its peak.

Santiago is divided into 13 political districts called *comunas.* Each comuna has an elected mayor. The quality of life varies significantly among the comunas. Wealthier comunas have modern buildings and well-tended public areas. Poor ones have some inadequate housing and unpaved roads.

A square called the Plaza de Armas forms the heart of downtown Santiago. The Cathedral of Santiago, City Hall, and many shops surround the plaza. Santiago's main roadway is the Avenida Bernardo O'Higgins, which runs through the center of the city. The longest of Santiago's four subway lines runs under this avenue.

Santiago has numerous theater, dance, and music companies. The Museum of Fine Arts and the Chilean Museum of Pre-Columbian Art are among the city's attractions. La Chascona, a house that was owned by the Chilean poet Pablo Neruda, is now a museum that features various objects he collected during his life. Institutions of higher education in Santiago include the Catholic University of Chile and the University of Chile.

The people. Most of Santiago's residents have Spanish ancestry, though some are of French, German, Italian, or Croatian descent. Other significant groups include American Indians and people from the Middle East and Korea. Many of Santiago's residents are *mestizos* (people of mixed white and Indian ancestry). About 95 percent of the city's people are Roman Catholics.

The people of Santiago live and dress much like city dwellers in the United States, Canada, and Europe. Many people live in houses with fenced-in gardens. During the late 1900's and early 2000's, increasing numbers of Santiago's residents moved to apartments.

Meals typically include fruits, vegetables, meats, and seafood products of the Central Valley and Pacific coast. Wine is plentiful and inexpensive. Popular foods include *empanadas* (meat-, seafood-, or cheese-filled pastries), *cazuela de ave* (a hearty chicken soup), *pastel de choclo* (a baked corn casserole), and *ceviche* (pickled fish).

Economy. Santiago is home to Chile's stock exchange and major banks. Much of the nation's industry is based in Santiago. A number of large firms have their headquarters in the city. Many Santiago residents work in factories that process food, or manufacture textiles, footwear, or other products. Many others work in government and service industries. Santiago's railroad station serves passengers traveling to the south. An international airport serves the city.

History. Araucanian Indians, often called the Mapuche, lived in what is now the Santiago area when Europeans arrived in the 1500's. A Spanish soldier named Pedro de Valdivia founded Santiago in 1541. It was the first permanent Spanish settlement in what is now Chile. In the late 1500's, Santiago became the seat of Spanish rule over the Chilean region and parts of Argentina. When Chile gained independence in 1818, Santiago became the nation's capital.

In 1879, Chile won lands rich in copper and nitrates by defeating Bolivia and Peru in the War of the Pacific. Santiago grew rapidly as a result of this new mineral wealth. Santiago's economy grew during World War I (1914-1918) because of the demand for nitrates used in making explosives. The city's industrial expansion continued after World War II (1939-1945). Skye Stephenson

See also **Chile** (picture).

Santiago, *SAHN tee AH goh* (pop. 278,638), is the second largest city of the Dominican Republic. Only Santo Domingo has more people. The city's full name is Santiago de los Caballeros (Spanish for *St. James of the Gentlemen*). Santiago lies on the Yaque del Norte River in the northern part of the country (see **Dominican Republic** [map]). Santiago is a distribution center for farm products, including cacao, coffee, fruits, sugar cane, and tobacco. The city's manufactured products include cigars, cigarettes, dolls, and clothing.

Santiago was founded about 1500 by Spanish explorers led by Bartholomew Columbus (a brother of Christopher Columbus). The city suffered extensive damage from earthquakes in 1564 and 1842, and from a fire in 1863. Gary Brana-Shute

Santiago de Cuba, *SAHN tee AH goh day KOO bah* (pop. 418,721), serves as the center of Cuba's mining industry. The city lies at the foot of the Sierra Maestra range on the southeast coast of Cuba. For location, see **Cuba** (political map). Santiago de Cuba is a shipping center for iron, manganese, sugar, coffee, and tobacco. Morro Castle, one of its landmarks, was built to defend

its harbor from British and French pirates. In 1898, during the Spanish-American War, a United States fleet destroyed most of the Spanish fleet near Santiago harbor.

Gary Brana-Shute

Santo Domingo, *SAHN toh doh MIHNG goh* (pop. 1,313,172), is the capital and largest city of the Dominican Republic. It lies at the mouth of the Ozama River on the southern coast (see **Dominican Republic** [map]). The city is an important seaport and airport. Its factories produce sugar products, textiles, and liquor. Resort hotels and beaches make it a popular tourist spot.

Santo Domingo is the oldest European-founded city in the Western Hemisphere. Bartholomew Columbus, a brother of Christopher Columbus, founded it in 1496 as *Nueva Isabela.* The Cathedral of Santo Domingo, completed about 1540, is the oldest church in the West Indies. Some historians say it holds Christopher Columbus's tomb.

A hurricane destroyed most of the city in 1930. The city was rebuilt along modern lines, but many of its buildings are in the Spanish colonial style. An impressive example is the Alcazar, the rebuilt palace of Viceroy Diego Columbus, Christopher's son. From 1936 to 1961, under dictator Rafael Trujillo, the city was called Ciudad Trujillo. Santo Domingo faces problems of overcrowding. Its population has doubled since 1970. Many poor people from the countryside have moved to the city.

Gary Brana-Shute

See also **Dominican Republic** (picture).

Santo Domingo, University of, in Santo Domingo, Dominican Republic, is the oldest university in the Western Hemisphere. It was established by Pope Paul III in 1538 as the University of Saint Thomas Aquinas. The Dominican Order of Preachers operated the school, granting degrees to lay students and clergy. The university became a lay institution in 1815. It offers courses in agronomy, architecture, business, engineering, law, medicine, philosophy, and veterinary medicine. It has an enrollment of about 52,000. P. A. McGinley

Santos (pop. 486,810) is the major port city of Brazil. It lies on Brazil's southeast coast, about 25 miles (40 kilometers) from the huge city of São Paulo (see **Brazil** [political map]). Santos is built on the sheltered inland side of a small island linked by bridges to the mainland.

In the 1860's, a railroad was built between Santos and São Paulo. The railroad helped Santos become a center of the import and export trade of São Paulo and much of southern Brazil. Today, the production of iron and steel, petroleum products, and hydroelectric power contribute to the city's economy. Many people who live in Santos work in São Paulo.

Portuguese colonists formed a settlement at the present site of Santos in the early 1500's. Santos became a town in 1586. J. H. Galloway

Santos-Dumont, *SAN tuhs doo MAHNT* or *SAHN tooz dyoo MAWN,* **Alberto** (1873-1932), a Brazilian inventor, pioneered advances in aviation in both lighter-than-air and heavier-than-air machines. He also used his wealth to promote aviation and to help other inventors.

Santos-Dumont was born in the state of Minas Gerais and was educated mostly in France. In 1898, he flew a cigar-shaped gas bag propelled by two small engines driving a single propeller. He built a box-kite airplane in 1905. Each wing was a box-kite, and a third box-kite was suspended ahead of the aircraft to provide control. In 1906, he flew it for eight seconds in the first motor-powered heavier-than-air flight in Europe. The main advantage of the box-kite construction was its light weight, about half that of the first Wright brothers' biplane. Santos-Dumont's work was a major stimulus to European aviation in the early 1900's. Roger E. Bilstein

See also **Airplane** (Other pioneer planes and fliers; picture: The Demoiselle).

Sanzio, Raffaello. See **Raphael.**

São Francisco River, *sown frahn SEE skoo,* is in eastern Brazil. It rises in the state of Minas Gerais and flows northeast through the state of Bahia. It then turns southeast. The river forms the boundary between Bahia and the state of Pernambuco and then between the states of Sergipe and Alagoas. It empties into the Atlantic Ocean, 1,988 miles (3,199 kilometers) from its source. As the river leaves the mountains in Minas Gerais, it plunges over falls and rapids. Then it is a broad, navigable stream for 900 miles (1,400 kilometers) of its middle course. But 200 miles (320 kilometers) from the Atlantic, the river again becomes swift as it tumbles over rapids and the Paulo Afonso Falls. The river is used for transportation and irrigation and for generating hydroelectric power.

J. H. Galloway

São Paulo, *sown POW loo* or *sow POW loh* (pop. 11,128,848; met. area pop. 17,112,712), is Brazil's largest city and leading commercial, financial, and industrial center. It is one of the largest cities in the world in terms of population. It is also the chief city in one of the most populous urban centers in the world (see **City** [table: The 50 largest urban centers in the world]). São Paulo is the capital of the state of São Paulo. The city lies in southeastern Brazil, about 240 miles (386 kilometers) west of Rio de Janeiro. For location, see **Brazil** (political map]).

In 1554, Jesuit missionaries from Portugal founded São Paulo as an Indian mission. It remained a small town until the mid-1800's, when it became the commercial center of Brazil's booming coffee industry. Plantation owners first used African slaves as laborers. After the abolition of slavery in Brazil in 1888, Asians and Europeans came to São Paulo State to work on the coffee plantations, and many later moved to São Paulo City. In time, the coffee growers invested much of their profits in industries in São Paulo. Today, the city and its surrounding area account for about half of Brazil's total industrial output.

The city lies on a high plateau about 30 miles (48 kilometers) from the Atlantic Ocean. A steep slope separates São Paulo from the coastal city of Santos, to the southeast. Santos serves as São Paulo's port (see **Santos**). São Paulo covers 576 square miles (1,493 square kilometers), and its metropolitan area occupies 3,070 square miles (7,951 square kilometers). The Tietê and Pinheiros rivers flow through the city.

Wide avenues and unusually designed skyscrapers give the city a modern appearance. Few of São Paulo's buildings are even 100 years old, though a chapel that was built in 1554 and a few old churches still stand. The center of the business district of São Paulo is called the Triangle. This name dates back to the 1500's, when three mission buildings that stood in the area were connected by paths that formed the shape of a triangle.

David R. Frazier

São Paulo, Brazil, ranks among the world's largest cities in population. Big, modern buildings crowd the city's busy downtown section, *shown here.* São Paulo is Brazil's leading commercial, financial, and industrial center.

Next to the Triangle on the northwest are many hotels and restaurants. A public square called the Plaza of the Republic features an arts and crafts market each Sunday. Mansions once lined the fashionable Paulista Avenue, southwest of the Triangle, but most have been replaced by skyscrapers. Apartment and office buildings also have taken the place of homes in the center of the city. Many people have moved to the suburbs.

São Paulo has a number of parks, the largest of which is the beautifully landscaped Ibirapuera Park. A monument to the *bandeirantes* (pioneers) of São Paulo stands at the entrance to the park. The nearby Santo Amaro lake region is a popular recreation area. Sports events are held at Morumbi and Pacaembu stadiums.

São Paulo faces many problems associated with a rapid population growth. For example, many homes have neither running water nor sewerage service. Other problems include air pollution, overcrowding, and traffic congestion. In an attempt to solve some of its problems, the city started several water and sewerage improvement projects during the early 1970's. Construction of commercial and recreational facilities outside the central part of the city helped relieve the overcrowding. A rapid transit system opened in 1974.

People of São Paulo are called *Paulistanos.* Most of them have ancestors who emigrated from Germany, Italy, Japan, Lebanon, Portugal, Spain, or Syria. Some Paulistanos have African or American Indian ancestry. Since the 1930's, immigration from other countries to São Paulo has decreased. At the same time, migration from other areas of Brazil to São Paulo has increased. Brazilians who move to São Paulo from other parts of the country do so largely because the city has more jobs and higher wages than other areas of Brazil.

Paulistanos speak a variety of languages, but most of them also speak Portuguese, Brazil's official language. Most of the people are Roman Catholics. Other religious groups include Protestants and followers of African religions.

Paulistanos have the reputation of being the most energetic, hard-working people in Brazil. But they also like to relax. After a morning at their job, many people eat a long, leisurely lunch before returning to work in the afternoon. The people of Sáo Paulo enjoy sports, especially soccer.

Poverty is a serious problem in São Paulo despite the city's prosperity. More than half the families have a monthly income of less than $150. Many of these families live in slum areas called *cortiços,* which consist of many shacks jammed together. The large-scale migration to the city intensifies the problem of poverty. Most of the people who move to São Paulo lack job skills, and many cannot find employment. The city has made some progress in providing job training and adequate low-cost housing for these people.

Education and cultural life. The University of São Paulo, which has about 54,000 students, is the largest university in Brazil. The city also is the home of the Pontifical Catholic University of São Paulo, Mackenzie University, and several fine-arts schools.

São Paulo's Municipal Library ranks as one of the largest public libraries in South America. The city also has a fine system of children's libraries. São Paulo's museums include institutions of art, folklore, forestry, history, Indian culture, and zoology. A scientific center, the Butantan Institute, became known for its development of snakebite serums.

São Paulo has sponsored an international art show known as the *Bienal* every other year since 1951. Theaters in the city present ballet, opera, concerts, and plays.

Economy. About 40 percent of São Paulo's workers have a job in construction or manufacturing. The city produces more than half of Brazil's chemicals, pharma-

ceuticals, and textiles, plus more than 75 percent of the country's electrical equipment, machinery, and rubber goods. São Paulo ranks as the leading Brazilian producer of motor vehicles. Other important products include cement, clothing, footwear, furniture, plastics, and processed foods. Nearby rivers provide São Paulo's industries with hydroelectric power.

Highways and railroads link São Paulo to agricultural areas and to other Brazilian cities. Two international airports serve the city.

São Paulo has become a major financial center, with many Brazilian as well as foreign banks. It also serves as the Brazilian or South American headquarters for a number of multinational companies.

History. Jesuit missionaries from Portugal founded São Paulo as an Indian mission in 1554. As a result of attacks by Indians, the Jesuit missionaries joined with some nearby Portuguese colonists and formed one community. The people of São Paulo were poor during this early period. Many of them organized groups to travel to the interior of South America in search of wealth. Members of these groups were known as *bandeirantes.*

Until the mid-1600's, the bandeirantes sought mostly Indians, whom they captured and sold as slaves to other settlers. The bandeirantes later prospected for gold and precious gems. In 1698, bandeirantes discovered gold northeast of São Paulo in what is now the state of Minas Gerais. The gold rush that followed this discovery produced little wealth for São Paulo. Instead, the port city of Rio de Janeiro captured the trade and wealth that came with the gold rush.

Cattle trading and sugar planting brought wealth to some Paulistanos. By 1800, São Paulo was a minor administrative and commercial center with only about 20,000 people. In 1822, Prince Regent Pedro of Portugal declared Brazil's independence while on a visit to São Paulo.

Coffee planting spread to the area near São Paulo during the mid-1800's. São Paulo soon became the commercial center of Brazil's coffee industry. The state government encouraged immigration, and foreigners poured into the area. São Paulo's industrial growth began in the late 1800's, when coffee profits were invested in new industries in the city. The population of São Paulo increased from about 32,000 in the 1870's to about 240,000 in 1900.

During the 1900's, São Paulo played an important part in Brazilian politics. In 1932, the city was the base of an unsuccessful revolt against President Getúlio Vargas. From 1968 to 1970, student protests and acts of guerrilla rebellion against the nation's military rule took place in São Paulo.

São Paulo's population grew rapidly during most of the 1900's. Since the 1990's, however, the rate of growth has slowed somewhat. Overcrowding, pollution, and high operating costs have caused some industries to relocate to nearby small towns or to move even farther away. J. H. Galloway

See also **Brazil** (pictures); **Latin America** (picture: Sprawling slums).

São Tomé, *SOWN taw MEH* (pop. 34,997), is the capital and largest city of São Tomé and Príncipe, an island country west of the African mainland. The city lies on the northeast coast of São Tomé Island. For the location of São Tomé, see **São Tomé and Príncipe** (map).

The city of São Tomé serves as a trading and shipping center for farm products of São Tomé and Príncipe. The country's only airport is near the capital. The Portuguese discovered São Tomé Island in 1470 and founded the city about 1500. Samuel Decalo

São Tomé and Príncipe, *SOWN taw MEH, PREEN see puh,* is an African country that consists of two main islands and several tiny islands. The two main islands—São Tomé Island and Príncipe Island—give the country its name. The islands lie in the Gulf of Guinea, about 180 miles (290 kilometers) west of Libreville, Gabon, on the African mainland.

São Tomé Island is much larger than Príncipe Island. It accounts for about 85 percent of the country's area and has about 95 percent of its people. Most of the people of São Tomé and Príncipe live in rural areas and work on farms. The city of São Tomé, on São Tomé Island, is the nation's capital and largest city. The city serves as a trading and shipping center for the country's farm products.

São Tomé and Príncipe became an independent nation in 1975. It had been ruled by Portugal for most of the period since the late 1400's. During the 1500's, São Tomé Island became a center of the African slave trade.

Government. São Tomé and Príncipe is a republic. The people elect a president to a five-year term. The president cannot serve more than two terms. The president appoints a prime minister and a cabinet to help run the government of the country. The National Assembly makes the nation's laws. The people elect its 55 members to four-year terms.

People. About 70 percent of the people of São Tomé and Príncipe have a mixed black African and European ancestry. Sometimes called Creoles, they are considered the native people of the islands. People from the African island country of Cape Verde and from the African mainland form the second largest group. Europeans account for a small percentage of the population.

Many of the Creoles own small farms or businesses, or work on fishing crews or as laborers. Some of the Europeans own farms, and others have jobs requiring technical or management skills. Most of the Africans from Cape Verde and the mainland are laborers with low-paying jobs.

Facts in brief

Capital: São Tomé (city).
Total land area: 372 mi² (964 km²). *Coastline*—129 mi (208 km).
Elevation: *Highest*—Pico de São Tomé, 6,640 ft (2,024 m). *Lowest*—sea level.
Population: *Estimated 2002 population*—153,000; density, 411 per mi² (159 per km²); distribution, 56 percent rural, 44 percent urban. *1991 census*—116,998.
Chief products: Bananas, cocoa, coconuts, coffee, copra, livestock.
Flag: The flag has green horizontal stripes (for forests and the sea) at the top and bottom; a yellow horizontal stripe (for soil) in the center; and a red triangle (for the struggle for freedom) near the staff. Two black stars symbolizing the country's two main islands appear on the yellow stripe. Adopted in 1975. See **Flag** (picture: Flags of Africa).
Money: *Basic unit*—dobra. One hundred centimos equal one dobra.

WORLD BOOK maps

Portuguese is the most widely used language in São Tomé and Príncipe. Many Creoles and Europeans speak a dialect based on Portuguese as it was spoken hundreds of years ago. Roman Catholicism is the main religion among the Creoles and Europeans. Africans from Cape Verde and the mainland use the language and practice the religion of their place of origin. By law, children in São Tomé and Príncipe are required to complete elementary school, but many do not do so. Relatively few children go on to high school.

Land and climate. The islands of São Tomé and Príncipe are part of a series of extinct volcanoes. The western part of São Tomé Island rises sharply from the sea, and forests grow near the shore. Inland, formations of basalt rock rise steeply toward the center of the island. The land gradually slopes downward from the center to the east coast. There, volcanic ash has formed deep deposits of fertile soil. Príncipe Island has a similar land pattern.

São Tomé and Príncipe islands lie a little north of the equator. The country has hot, humid weather from September through May; and hot, dry weather from June through August. The average annual temperature varies from 77 °F (25 °C) in the lowlands to about 65 °F (18 °C) in the highlands. The annual rainfall averages 16 inches (41 centimeters).

Economy of São Tomé and Príncipe is based on agriculture. But fishing is also important in the country. São Tomé and Príncipe has little manufacturing or mining.

About 90 percent of the nation's cultivated land belongs to agricultural companies that operate large commercial farms. The other 10 percent of the land is divided among about 11,000 small farm owners. The chief products are bananas, cocoa, coconuts, coffee, copra, and livestock.

The country has about 180 miles (290 kilometers) of roads. An airport lies near the city of São Tomé.

History. Portuguese explorers discovered the islands of São Tomé and Príncipe in 1470, during the great age of Portuguese discovery. The islands were uninhabited at the time.

About 1485, Portugal began to send convicts, exiles, and settlers to the islands. These people tried to raise sugar, which was in great demand in Europe. But growing sugar requires great physical labor, and there were not enough people to produce large crops. The Portuguese then started to bring slaves from the African mainland to work on the sugar plantations. The islands soon ranked among the world's leading sugar producers.

In the mid-1500's, many slaves on São Tomé Island revolted against the plantation owners. A number of owners abandoned their plantations, and sugar production declined. By that time, many nations were involved in the African slave trade. São Tomé Island became a major center of it. Slaves from the mainland of Africa were sent to São Tomé and then shipped to the Americas and elsewhere.

The Dutch and the French ruled São Tomé Island during periods of the 1600's and 1700's, but the Portuguese regained control. In the 1800's, Portuguese planters began to grow coffee and cocoa on the islands. They used slave labor to help raise these crops.

Portugal and most other nations ended slavery in the 1800's. But the Portuguese continued to bring mainland Africans to São Tomé and Príncipe as contract laborers. These workers were treated harshly, and they revolted unsuccessfully from time to time during the 1800's and 1900's. In 1953, Portuguese troops killed hundreds of workers during a protest. This event is called the Batepa massacre.

In the mid-1900's, many people in São Tomé and Príncipe began demanding an end to Portuguese rule. The islands gained independence on July 12, 1975. Since then, the country's leaders have maintained strong relations with Portugal. São Tomé and Príncipe has received loans from Portugal for airport and road construction.

James W. Fernandez

See also **São Tomé**.

Saône River, *sohn,* is a waterway in eastern France. It rises near the foothills of the Vosges Mountains and flows for 268 miles (431 kilometers) past the vineyards of Burgundy. The Saône, the most important tributary of the Rhône River, joins it at Lyon. Light ships can sail on it for 232 miles (373 kilometers). The industrial city Chalon-sur-Saône lies on its banks. Canals connect the Saône River to the Moselle, Marne, Yonne, and Loire rivers. For location, see **France** (terrain map). Hugh D. Clout

Sap is the liquid found in the stems, roots, and leaves of plants. Seed plants contain two types of sap, *cell sap* and *vascular sap.* Some plants also produce other kinds of saps when they are cut or injured.

Cell sap. Each plant cell contains a saclike structure, called a *vacuole,* that is filled with cell sap. The vacuole takes up most of the space within the cell. Cell sap is released when plant cells are broken or crushed. The cell sap of the sugar beet and the sugar cane contains much sugar. These plants are the chief sources of commercial sugar. Sugar also accumulates in the cell sap of many fruits as they ripen.

Vascular sap flows through plants in specialized tissues called *xylem* (pronounced *ZY lehm*) and *phloem* (*FLOH ehm*). The xylem consists of cells that carry one kind of sap up from the roots, through the stem, and to the leaves. This sap consists of water and dissolved minerals. It is used by the leaves to produce another kind of sap that the plant uses for food. This second sap, made up of sugars dissolved in water, is transported from the leaves to other parts of the plant by cells in the phloem.

The water and minerals in the xylem are absorbed from the soil by a plant's many root tips in a process called *osmosis.* Each root tip has an area called the *apical meristem* that produces new cells. Most of the water and minerals are absorbed by threadlike *root hairs* that grow behind the apical meristems.

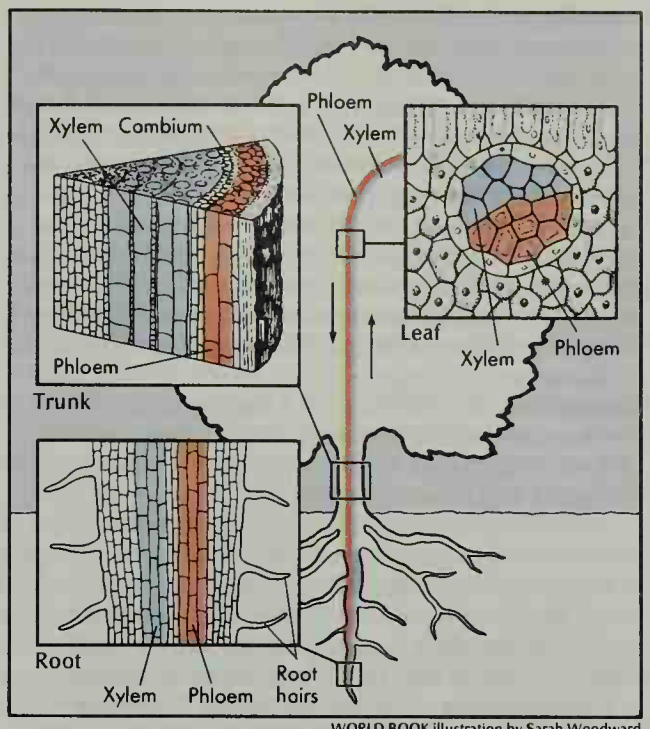
Once in the root, sap moves between cells and from cell to cell until it passes into the xylem. Pressure created by the root cells during osmosis then pushes the sap in the xylem up toward the leaves. At the same time, water is constantly lost by evaporation through tiny pores in the leaves. This process is called *transpiration.* As the leaf cells lose water, the evaporating water molecules create a force that pulls more sap upward. This extra pull is needed to draw water to the leaves at the top of a plant.

The leaves use energy from the sun to combine water and carbon dioxide into sugars that the plant needs for food in a process called *photosynthesis.* As molecules of sugar accumulate, they move out of leaf cells and into the phloem. Water enters the phloem by osmosis from surrounding cells and the xylem. As a result, pressure builds up in the phloem and moves the sap downward to the stems and roots. There, the sugar molecules are converted into starch and are stored. Some insects, such as aphids and scale insects, use their sucking mouthparts to pierce the stems of plants and obtain the sap in phloem for food.

In trees and other woody plants, a layer of tissue inside the trunk produces new layers of phloem and xylem each year. This layer of tissue is called the *cambium.* The xylem grows inward from the cambium, and phloem grows outward from the cambium. The phloem forms part of the bark and is constantly being shed. The xylem, which is a tree's wood, accumulates in the central part of the trunk.

As a tree matures, the oldest wood no longer transports water and minerals. This dead wood, called *heartwood,* supports the tree and holds it upright. The wood that surrounds it, called *sapwood,* carries sap from the roots to the leaves. In the spring, stored sugars are carried upward in the sapwood to the growing leaves. At this time of the year, people tap holes in the sapwood of sugar maples to collect the sweet sap used to make maple syrup.

Other saps. Some plants release special saps when they are wounded. For example, milkweeds produce a liquid called *latex* when their stems are cut or broken. This liquid is usually white, but also may be yellow or red. Rubber trees produce a white latex that flows out of the trunk when it is cut. This latex is used to make rubber. Pine trees produce a gummy fluid called *resin* that oozes out when the stems, leaves, or bark are damaged. Latexes and resins are not true saps because they are not carried in xylem or phloem tissues. They are stored and released by other specialized plant structures.



WORLD BOOK illustration by Sarah Woodward

Vascular sap moves through a tree in specialized tissues called *xylem* and *phloem.* The xylem transports sap up from the roots, through the trunk, and to the leaves. The phloem carries sap down from the leaves to other parts of the tree.

Joseph E. Armstrong

Related articles in *World Book* include:

Cell (Chloroplasts)
Gum
Maple syrup (Production)
Osmosis
Resin
Rubber
Tree (How trunks and branches grow thicker)
Turpentine

Sapajou. See Capuchin.

Sapir, *suh PEER,* **Edward** (1884-1939), was an American anthropologist and linguist who explored the relationships between language, culture, and personality. In anthropology, Sapir helped found two new branches of study: (1) *linguistic anthropology,* which analyzes the role of language in different societies, and (2) *psychological anthropology,* which examines the relationship between culture and personality. He also formulated methods by which scholars can reconstruct the history of a culture in the absence of written evidence. Sapir greatly influenced the modern anthropological concept of culture. This concept emphasizes patterns of acquired traits and the relationship between personality and culture.

In linguistics, Sapir contributed to the study of the structure and history of languages and to the analysis of the differences and similarities between languages. He pioneered several new fields of linguistics, including

ethnolinguistics, which studies the relationship between language and culture, and *psycholinguistics,* which investigates the mental processes involved in language. Sapir's writings include many articles and one full-length book, *Language: An Introduction to the Study of Speech* (1921). Most of his descriptive studies of languages and cultures dealt with American Indians.

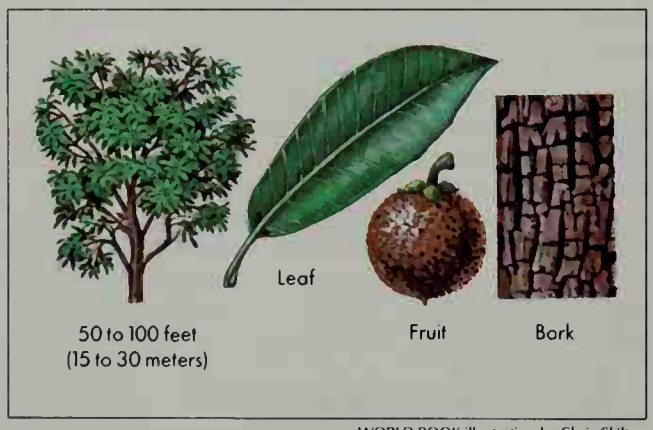
Sapir was born on Jan. 26, 1884, in Lauenberg, Germany (now Lebork, Poland). He came to the United States with his family when he was 5 years old. He taught at several universities, including the University of Chicago and Yale University. Sapir died on Feb. 4, 1939.

Igor Kopytoff

Sapodilla, *SAP uh DIHL uh,* is a tropical fruit native to Mexico and Central America. It also is grown commercially in parts of Asia. In the United States, sapodillas are cultivated only in southern Florida.

Sapodillas may be round, oval, or cone-shaped. The ripe fruit ranges from 2 to 4 inches (5 to 10 centimeters) in diameter. It has rough, grayish-brown skin. The soft, sweet flesh is yellowish-brown and full of large black seeds. The sapodilla is a good source of potassium and vitamin C. People eat sapodillas fresh or in sherbet.

The fruit grows on an evergreen tree that can reach a height of about 100 feet (30 meters). The trees are grown



WORLD BOOK illustration by Chris Skilton

The sapodilla tree has leathery evergreen leaves. The flesh of the fruit is thick, soft, and sweet. The bark contains a milky juice that is boiled to make *chicle,* an ingredient of chewing gum.

either from seeds or by *grafting* (see **Grafting**). Grafted trees produce fruit after four or five years, but trees that are grown from seed take several years longer. Sapodilla trees contain a milky juice called *latex* beneath their bark. The latex is boiled to make *chicle,* an important ingredient in chewing gum (see **Chicle**).

Philip J. Ito

Scientific classification. The sapodilla belongs to the sapodilla family, Sapotaceae. It is *Manilkara zapota.*

Sapphire, a hard and clear gem, is a variety of the mineral corundum. The best-known sapphires are blue. Their color results from small amounts of iron and titanium in the stone. Sapphires are also found in many other colors, including yellow, green, white, black, violet, and orange. Nonblue sapphires are called fancy sapphires. The red variety of corundum is known as a ruby.

The most valuable sapphires once came from Kashmir, in India. They are a magnificent cornflower blue, the color to which all sapphires are compared. Today, Thailand is the most important source of blue sapphires. Blue and fancy sapphires are also found in Myanmar, Sri Lanka, Australia, and the state of Montana in the United States.

Star sapphires contain needles of the mineral rutile that reflect light in six starlike rays. The most highly prized star sapphires are blue. Black or white star sapphires are less valuable. One of the largest blue star sapphires, the *Star of India,* weighs 563 carats, or about 4 ounces (110 grams). It is on exhibit in the American Museum of Natural History in New York City.

Among minerals, sapphires and rubies rank second only to diamonds in hardness. For this reason, sapphires are sometimes used as abrasive or polishing agents. Large numbers of inexpensive imitation sapphires are manufactured every year. But the natural stones have maintained their high value because of a demand for the real gems. *Gemologists* (gem experts) can distinguish between imitation and natural sapphires. The sapphire is the birthstone for September.

Robert I. Gait

See also **Corundum; Gem** (picture); **Ruby.**

Sappho, *SAF oh,* was a Greek lyric poet who lived about 600 B.C. Her only surviving verse consists of one probably complete poem and fragments of many others. These lines show intense but controlled emotion expressed in direct language. They demonstrate Sappho's keen powers of observation and her ability to capture in a few words insights into the world of both nature and human nature. Later poets, especially the Roman poets Catullus and Horace, imitated Sappho's four-line stanza, called the *Sapphic.* See **Poetry** (Ancient poetry).

Sappho was born into an aristocratic family at either Eresos or Mytilene (now Mitilini) on the island of Lesbos. At Mytilene, she led a circle of young women who were her disciples. These women worshiped Aphrodite and other goddesses, and learned music and other arts as well as social graces. Although some of Sappho's lyrics celebrate friendship among women, her circle was for the young, who often left the group to marry. Sappho herself valued the company of both men and women. She was married and had a daughter named Cleis.

Cynthia W. Shelmerdine

Sapporo, *suh POHR oh* (pop. 1,822,300), is the capital of Hokkaido, the northernmost island of Japan. The city is on the western part of the island near Otaru Bay. For location, see **Japan** (political map).

Sapporo was laid out in 1871 and was patterned after western cities. Today, Sapporo serves as the island's manufacturing and cultural center. Products of the island include hemp cloth and rubber goods, as well as such food products as condensed milk and processed soybeans. Sapporo's chief attractions include Hokkaido University and the botanical gardens, which specialize in alpine flora. There are also ski slopes, in the suburbs, and Jozaankei hot springs, 11 miles (18 kilometers) southwest of the city. In 1972, the Winter Olympic Games took place at Sapporo.

Kenneth B. Pyle

Saprophyte, *SAP ruh fyt,* is a living thing that gets its food from the remains of dead organisms. Most saprophytes are either fungi—such as mushrooms and molds—or bacteria. These organisms lack chlorophyll, the green pigment that allows plants to make their own food by *photosynthesis* (see **Photosynthesis**). Saprophytes digest dead tissue for the energy they need to grow and reproduce. This process commonly involves

using up carbohydrates to produce carbon dioxide and water. Saprophytes also may digest proteins, fats, or other substances made by living things and break them down into simpler compounds.

The simple compounds produced by saprophytes can be taken up and reused by other organisms. Thus, saprophytes play an important part in the nutrient and energy cycles of living things. David H. Wagner

See also **Fungi; Mushroom.**

Sapsucker is one of a group of birds of the woodpecker family. It lives only in North America. Sapsuckers are so called because part of their diet includes sap from trees. They get this sap by making small holes called *wells* in the bark. They also feed on insects attracted to the sap and on ants and wild fruit. The common sapsucker in the East is the *yellow-bellied sapsucker.* The male has a bright scarlet crown and throat, and black upper parts with white markings. This sapsucker nests in the northern United States and Canada. In the winter, it flies as far south as Central America. It nests in holes in trees. The female lays three to seven pure white eggs. The western *red-breasted sapsucker* lives on the Pacific Coast. The adults of both sexes have a red crown, throat, and breast. *Williamson's sapsucker* is found in mountain regions of the western United States.

John Shaw, Bruce Coleman Ltd.

Sapsucker

Sapsuckers have much the same habits as woodpeckers but sometimes injure trees. Williamson's sapsucker, however, does little damage to trees. Fred J. Alsop III

Scientific classification. Sapsuckers are members of the woodpecker family, Picidae. The yellow-bellied sapsucker is classified as *Sphyrapicus varius;* the red-breasted is *S. ruber;* and Williamson's sapsucker is *S. thyroideus.*

Saracens, *SAR uh suhnz,* were Muslims from what are now Saudi Arabia, Iraq, and Iran who invaded parts of the Christian world from the 600's to the 1000's. The Saracens included the people of Palestine and Syria, the Arab Moors who set up the Spanish kingdom in the 700's, and the Seljuks who fought the Crusaders. The Greeks and Romans first used the term *Saracen* to describe the wandering Arab tribes of the Syro-Arabian Desert. George Ciacumakis, Jr.

Saragossa, *SAR uh GAHS uh,* also spelled *Zaragoza, ZAHR uh GOH zuh* (pop. 586,219), is an industrial and trading center in northeastern Spain (see **Spain** [political map]). The city has metalworks, sugar refineries, chemical plants, and factories that manufacture electrical equipment, agricultural machinery, and furniture.

The central part of Saragossa is a district of ancient, crowded lanes and dilapidated houses. An attractive newer section has grown up around the old quarter.

The city's name comes from *Caesarea Augusta,* which was the name Emperor Augustus gave to the settlement in 25 B.C., when he made it a Roman colony. Saragossa was the capital of the old kingdom of Aragon from the 1100's to the 1400's. Stanley G. Payne

Sarajevo, *SAR uh YAY voh* (pop. 447,687), is the capital of Bosnia-Herzegovina (see **Bosnia-Herzegovina** [map]). It is famous for the products of its carpet weavers and silversmiths, and for its many *mosques* (Muslim houses of worship). Turks—who ruled the city from the 1400's to 1878—built the mosques. In 1914, Austrian Archduke Franz Ferdinand was assassinated in Sarajevo. This event started World War I (see **World War I** [introduction]). Sarajevo hosted the 1984 Winter Olympics.

From 1946 to 1992, Bosnia-Herzegovina was part of the federal state of Yugoslavia. In 1992, it declared independence. Most of the country's ethnic Muslims and Croats supported independence, but most ethnic Serbs did not. After independence was declared, the Serbs, backed by the Yugoslav National Army, began a war against non-Serbs. Serbian forces set up artillery in the hills overlooking Sarajevo and shelled parts of the city. Thousands of people were killed, and many buildings were damaged or destroyed. A peace agreement ended the conflict in late 1995, and the people of Sarajevo then began the task of rebuilding the city. Sabrina P. Ramet

See also **Bosnia-Herzegovina** (picture).

Sarasota, *SAR uh SOH tuh* (pop. 52,715), lies on Sarasota Bay on Florida's west coast (see **Florida** [political map]). Its chief industry is tourism. The Ringling Brothers and Barnum & Bailey Circus had winter quarters there from 1927 to 1960. Sarasota still has the John and Mable Ringling Museum of Art and its Circus Galleries. Sarasota County calls itself the center of Florida's Cultural Coast. Its attractions include the Van Wezel Performing Arts Hall, the Asolo Theatre Company, and ballet, opera, and orchestral troupes. Sarasota and Bradenton form a metropolitan area with 589,959 people. Scottish families founded Sarasota in the 1880's. Sarasota has a council-manager form of government. Peter O. Muller

Saratoga, Battle of. See **Revolutionary War in America** (Victory at Saratoga; picture).

Sarcoidosis, *SAHR koy DOH sihs,* is a disease in which small tumorlike lumps form in many parts of the body. Most scientists think it is caused by an excessive reaction by the immune system to an unknown stimulus. Scientists believe sarcoidosis is not contagious.

Sarcoidosis can occur in one or more organs, including the bones, eyes, liver, skin, and spleen. In most cases, it occurs in the lymph nodes of the chest and lungs. Lymph nodes are special tissues that help the body fight infection (see **Lymphatic system**). The disease seldom causes death, but it can lead to severe lung damage or damage to other organs.

Symptoms of sarcoidosis may resemble those of cancer or tuberculosis. Sarcoidosis in the lungs may cause coughing, accompanied by fatigue or fever. But some victims of the disease never develop its symptoms.

A chest X ray can indicate the possibility of sarcoidosis, but final diagnosis requires examination of tissue from one of the lumps. Sometimes lung tissue must be examined to confirm the diagnosis.

Most sarcoidosis victims are from 20 to 40 years old. Ireland, Norway, and Sweden have reported the most cases of sarcoidosis in proportion to population. In the United States, the disease occurs among a higher pro-

portion of African Americans and Puerto Ricans than of other groups. Some sarcoidosis patients have been effectively treated with the drug *cortisone*. Many people who have the disease in only the chest or lungs recover without treatment in a period ranging from a month to two years. Janice Phillips Dutcher

Sarcoma. See **Cancer** (Classification by body tissue).

Sarcophagus, *sahr KAHF uh guhs,* is a stone coffin. The ancient Egyptians probably first made a sarcophagus for the burial of a king or other important person. Some early Egyptian sarcophagi were shaped like small houses, others as ovals or oblongs. Later, many were cut in human form and carved with facial features. Many were covered inside and out with inscriptions and figures of gods intended to protect the body from decay. The Greeks often decorated sarcophagi with carved basreliefs. The Etruscans made sarcophagi of terra cotta. The Romans used marble or stone.

The best-known modern sarcophagi include those of George Washington in Mount Vernon, Napoleon Bonaparte in Paris, the Duke of Wellington in London, and the tomb of V. I. Lenin in Moscow. Leonard H. Lesko

See also **Napoleon I** (picture); **Tomb**; **Sculpture** (picture: The Alexander Sarcophagus).

Sardine is a member of the herring family and an important food fish. The word *sardine* refers to several groups of fishes. But it is used mainly for such species as the *Pacific sardine,* the *South African sardine,* and the *European sardine,* also called the *pilchard.* Other members of the herring family, including sprats and young Atlantic herring, are also sold as sardines. The fish were called *sardines* because they were first caught near Sardinia, an Italian island in the Mediterranean Sea.

Sardines live in temperate to tropical ocean waters near the shores of almost all the continents. They are especially plentiful off the coasts of Japan, northwestern Africa, and western South America. Sardines average 9 to 12 inches (23 to 30 centimeters) in length and about 4 ounces (113 grams) in weight. The upper part of their body is bluish-gray, and the lower part is silvery. Adult sardines usually swim in large schools. They feed on small aquatic organisms called *plankton.*

Most sardine fishing takes place on moonless nights. The movement of sardines disturbs tiny organisms that live near the surface of the sea. The movement causes these organisms to produce light by means of a chemical reaction. This light, called *bioluminescence,* reveals the presence of sardine schools. Most sardines are caught with a special type of net called a *purse seine.*

WORLD BOOK illustration by Colin Newman, Linden Artists Ltd

A European sardine, or pilchard, grows from 9 to 12 inches (23 to 30 centimeters) long. European sardines live in waters off the coasts of western Europe and northern Africa.

The U.S. fishing industry caught great numbers of Pacific sardines until the mid-1940's. At that time, the catch of these sardines began to decline severely. The decline probably resulted from a combination of excessive fishing and unfavorable environmental conditions. In 1967, the California legislature stopped all sardine fishing off the coast of California. As a result, the Pacific sardine population in U. S. waters began to increase. In 1986, California started to allow limited sardine fishing.

Cans of sardines are a familiar sight on supermarket shelves. Canneries precook sardines and remove part of their natural oil and moisture. Industry uses sardine oil in such products as linoleum, paint, and varnish. Some sardines are made into fish meal, which is used in animal feed and fertilizer. Small sardines are used as bait in commercial tuna fishing.

Scientific classification. Sardines belong to the herring family, Clupeidae. The European sardine is *Sardina pilchardus.* The Pacific sardine is *Sardinops sagax.* Tomio Iwamoto

See also **Fish** (picture: Thousands of sardines); **Fishing industry.**

Sardinia, *sahr DIHN ee uh,* is an Italian island in the Mediterranean Sea. It lies west of the mainland of Italy and over 100 miles (160 kilometers) from it. The nearest land is the French island of Corsica, 9 miles (14 kilometers) north across the Strait of Bonifacio. Sardinia's Italian name is Sardegna. It is second largest of the Mediterranean islands. Only Sicily is larger. Sardinia is about 166 miles (267 kilometers) long from north to south. It has an area of 9,301 square miles (24,090 square kilometers). This island and some small ones nearby form the region of Sardinia, which has a population of about 1 ½ million. For location, see **Italy** (terrain map).

Nine-tenths of Sardinia is mountainous. The only important area of lowlands is the southwestern plain. Human settlement in the mountains is difficult because the steep slopes and heavy rainfall produce landslides and floods. The agricultural improvement of the small areas of level land was retarded in places by swamps and elsewhere by lack of moisture during the hot, dry summers. These problems have been largely overcome by drainage projects and by irrigation. The most important agricultural products include almonds, grapes, herbs, lemons, olives, oranges, and wheat. Many goats and sheep are raised. Tunny and lobster are brought in to local fisheries. Sardinia is also one of Italy's leading cork producers. Ancient mines still produce copper, iron, lead, lignite, manganese, silver, zinc, and other minerals.

Sardinia is divided into the provinces of Cagliari, Nuoro, Oristano, and Sassari. The city of Cagliari, at the south end of the island, is the region's capital and its largest city. The Costa Smeralda (Emerald Coast) in northeastern Sardinia attracts many tourists.

Sardinia was invaded and ruled by first one power and then another. These included Carthage, Rome, the Vandals, Byzantium, the Muslims, the city-states of Pisa and Genoa, and Aragon. Sardinia preserves many ancient customs, traditions, and costumes.

During World War II (1939-1945), Sardinia became an important airplane and naval base for Italy. In 1943, American planes smashed two convoys at Sardinia, and destroyed many airfields. American Flying Fortress at-

tacks later damaged more Italian vessels in Sardinia. But the war made little permanent impression on Sardinia.

Since the war, the Italian government and the government of Sardinia have attempted to improve living conditions on the island. Large construction projects have made water and electricity more widely available. Many roads have been improved. Tourism has become an important part of the economy. Factories have been built, but unemployment remains a problem.

Anthony James Joes

See also **Sardinia, Kingdom of.**

Sardinia, *sahr DIHN ee uh,* **Kingdom of,** became the nucleus of united Italy. The kingdom was founded in 1720 when the Duchy of Savoy, a territory in northwest Italy, was joined with the island of Sardinia. The kingdom included the Piedmont region, around which the Duchy of Savoy was centered. As a result, the kingdom is also known as Piedmont-Sardinia or simply Piedmont. Victor Amadeus II of Savoy became the first monarch of the Kingdom of Sardinia.

Pinned between French, Austrian, and Spanish powers, the Kingdom of Sardinia nevertheless maintained its independence and expanded its territory during the 1700's. But in 1801, Napoleon Bonaparte annexed the Piedmont region to France, leaving only the island of Sardinia under the king's control. After Napoleon's defeat in 1814, Piedmont was returned to the Kingdom of Sardinia, and Genoa and Liguria were added to the kingdom. As a result, the Kingdom of Sardinia became the foremost independent state of the Italian peninsula.

By the 1830's, many Italians wanted to establish a unified Italian republic. These nationalists placed their hope in Charles Albert, who became monarch of the Kingdom of Sardinia in 1831. He granted his people a constitution in 1848. That same year, the Italian region of Lombardy revolted against Austrian rule, and Charles Albert sent troops to help drive the Austrians out of Italy. The king suffered a defeat at Novara, and he abdicated in favor of his son, Victor Emmanuel II.

The movement to unify Italy finally succeeded through the efforts of the Kingdom of Sardinia's prime minister, Camillo Benso, the Count di Cavour. Cavour obtained an alliance with France and provoked war with Austria in 1859. In a separate peace with Austria, France obtained Lombardy for the Kingdom of Sardinia. Patriots in several other states in northern and central Italy overthrew their rulers in 1859 and voted for union with the Kingdom of Sardinia in 1860. That year, Giuseppe Garibaldi and his followers brought southern Italy into the nation. In 1861, Victor Emmanuel II became king of a united Italy that included Sardinia. Susan A. Ashley

See also **Cavour, Count di; Italy** (History; map: Unification of Italy); **Sardinia; Victor Emmanuel II.**

Sardonyx, *SAHR duh nihks* or *sahr DAHN ihks,* is a variety of *chalcedony,* a fine-grained form of the mineral quartz. Most sardonyx has straight or slightly curved bands of reddish-brown and white. The chief sources of sardonyx are Brazil, Uruguay, and India. Sardonyx is one of the less expensive gemstones. It is used in jewelry. Jewelers usually cut it flat or with a domed shape to bring out the bands of color. Cameos are sometimes cut from sardonyx to take advantage of its color. Sardonyx is one of the birthstones for August. Robert I. Gait

See also **Cameo; Chalcedony; Gem** (picture); **Onyx.**

Sargasso Sea, *sahr GAS oh,* is an irregular oval-shaped area of the North Atlantic Ocean. Its center is about 2,000 miles (3,200 kilometers) west of the Canary Islands. It lies roughly between the 20th and 40th parallels of north latitude and between the 35th and 75th meridians west of Greenwich. No land boundaries mark off this body of water from the rest of the open ocean. It is set apart only by the presence of seaweeds that float on its surface. It is also a region of slow ocean currents surrounded by a boundary of rapidly moving currents, such as the Gulf Stream and the North Equatorial Current. The Sargasso Sea derives its name from *sargaço,* a Portuguese word for *seaweed.* Christopher Columbus is given credit for the first reliable report on this region. He took tests in 1492 to make sure that no rocks lay beneath the sea's weeds.

The legends of the sea

The early navigators who sailed their small ships to North America saw the Sargasso Sea as patches of gulfweed that seemed to form wide-spreading meadows. Soon there were legends and myths about the region that told of large islands of thickly matted seaweed inhabited by huge monsters of the deep. Poets and novelists used their imaginations in describing the sea. They pictured a blanket of netted seaweed from which no ship could escape once it became tangled in the weeds. They described many of the ghost ships of the past as huddled together in a weaving, rotting mass. Shapeless hulks of ancient galleons, covered with weeds and barnacles, were pictured lying beneath the waters of this mysterious sea. The passing years contributed skeletons of slave ships, then of pirate ships, and later of the gallant ships of Revolutionary War days. Wrecks of clipper ships and the latest doomed ships completed the legendary collection.

WORLD BOOK map

The Sargasso Sea

The facts about the sea

Scientists have changed the picture of the Sargasso Sea. They have shown that its area is about 2 million square miles (5.2 million square kilometers), and they have opened up fascinating research problems.

Origin of the seaweed. Scientists believe that the seaweed first came from the shores of the West Indies, after it had been torn loose by wind and waves. Parts of it adapted to living and growing in the open sea. The weeds developed a method of reproduction that enables them to multiply and grow without producing seeds. Waves break off sections of the mature weeds. These fragments then grow into full-size seaweeds in the same way that a cutting from a grape plant grows into a large grapevine. The weeds are supported by air sacks which resemble tiny grapes and grow as a part of the weeds. Sargassum weeds grow in many ocean regions. One variety is used as food in Japan.

Many small marine animals have adapted themselves to growing on and among the weeds. These animals in-

clude tiny crabs, shrimps, and barnacles. Sargassum fish are difficult to distinguish from Sargassum weeds, because the fish have taken on the colors and patterns of the weeds.

The greatest quantity of seaweed is found in the central part of the Sargasso Sea. It occurs in scattered masses, some 100 feet (30 meters) in diameter. Wind action forms long strips of the weed, which follow the general direction of the wind. Patches of the weed may cover more than 1 acre (0.4 hectare). Nowhere is the region so thickly covered that the weeds can interfere with the movements of a ship. Sometimes, unusually strong winds or currents cause some of the weeds to drift into the Gulf Stream, and eventually to New England or even Ireland and Norway.

Waters of the sea. The waters of the Sargasso Sea have many distinctive features. The water has an unusually deep blue color; a high salt content (3.7 per cent); a high temperature (up to 83 °F, or 28 °C); and extreme clearness (light can penetrate to a depth of as much as 3,300 feet [1 kilometer]). These features result chiefly from the location of the sea and its great depth, averaging over 3 miles (4.8 kilometers). However, because water largely circulates within the sea, oil and solid-waste pollution sometimes collect there.

Gerald R. Showalter

See also **Eel**; **Seaweed**.

Sargent, John Singer (1856-1925), was an American painter who did his major work in Europe. He lived much of his adult life in England. Today, his works hang in English and American collections as examples of English painting of the late 1800's.

Sargent established his reputation as a portrait painter, and is best known for his dashing portrayals of fashionable subjects. Sargent broadly brushed in his subjects' clothing or accessories, while capturing their personalities with remarkable penetration.

The Daughters of Edward Darley Boit (1882), an oil painting on canvas; Museum of Fine Arts, Boston

A painting by John Singer Sargent was one of the artist's earliest elegant and fashionable portraits. Sargent gained international fame for his realistic but flattering portraits.

Sargent was born in Florence, Italy, to American parents. He made the first of many trips to the United States in 1876. He studied in Italy and France and his first major exhibition was at the Paris Salon of 1878. Sargent moved to London in 1884 and made England his permanent home although he never became a British subject. During the last dozen years of his life, he virtually gave up portrait painting to paint more personally satisfying subjects, especially landscapes in water colors and oil, and to do murals for commissions. Sargent's murals may be seen in Boston at the public library and at the Museum of Fine Arts.

Sargent received many awards and honors during his lifetime, but his reputation declined after his death. However, since the mid-1950's interest in his work has revived considerably. Charles C. Eldredge

Sargon of Akkad, *SAHR gahn, AK ad* or *AH kahd,* was a king who founded the first great empire in history. He built his empire in Mesopotamia (now mostly Iraq) during the 2300's B.C. and gained control over much of southwestern Asia. Sargon was an outstanding military leader and administrator. He was one of the earliest kings to maintain a permanent army and to appoint associates from the royal court to serve as the governors of conquered cities. He organized his empire so well that it survived under his successors for over 60 years.

Sargon started his political career as a high court official under King Ur-Zababa of Kish, one of the city-states of Sumer in southern Mesopotamia (see **Sumer**). Sargon later conquered Kish and the other Sumerian city-states. Then he led his soldiers to a series of victories that extended his empire to what is now Iran in the east and to the Mediterranean Sea and Asia Minor (now Turkey) in the west. In central Mesopotamia, Sargon built a magnificent capital city called Akkad (or Agade). He reigned for 56 years. Sargon was a Semite, a person who speaks a Semitic language, such as Arabic or Hebrew. During his rule, Semites replaced the Sumerians as the most powerful inhabitants of Mesopotamia. These Semites and their language came to be called Akkadian, after Sargon's capital.

Sargon's fame gave rise to many legends about him. One legend describes the infant Sargon as being rescued from a basket floating in a river. There is a similar story about Moses, the great Israelite leader who lived about 1,000 years later. John A. Brinkman

Sari. See **India** (Clothing).

Sark, *sahrk,* is one of the Channel Islands, about 70 miles (110 kilometers) south of England and 22 miles (35 kilometers) off the French coast. Sark is only about 3 miles (4.8 kilometers) long and $1\frac{1}{2}$ miles (2.4 kilometers) wide. It has about 420 people and an area of 2 square miles (5 square kilometers).

Sark is the smallest self-governing unit in the United Kingdom. Many bays and coves cut into the coastline. Cliffs rise on all sides of the island. Tractors are the only motor vehicles allowed on Sark. The major forms of transportation on the island are bicycles and horse-drawn carriages. D. Ian Scargill

See also **Channel Islands**.

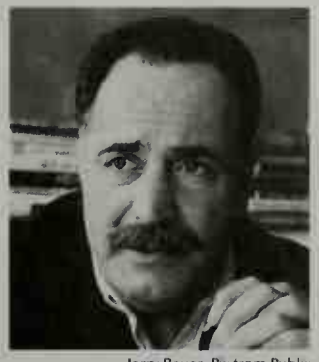
Sarnoff, David (1891-1971), an American businessman, was one of the first people to see the full possibilities of using radio and television to entertain the public. From 1930 to 1949, he served as president of the Radio

Corporation of America (RCA). As chairman of the board from 1947 to 1970, Sarnoff built RCA into a major radio and television manufacturer.

Sarnoff was born on Feb. 27, 1891, in Uzlyany, Russia (now Belarus), near Minsk. He came to the United States in 1900. In 1906, Sarnoff taught himself Morse code and was hired by the Marconi Wireless Telegraph Company of America. In 1912, Sarnoff picked up signals about the sinking liner *Titanic*. For 72 consecutive hours, he relayed the names of survivors. American Marconi became part of RCA in 1919, and at Sarnoff's urging, RCA formed the National Broadcasting Company (NBC) in 1926. In the 1930's, Sarnoff worked to develop commercial telecasting. He later led efforts to develop color TV.

Joseph H. Udelson

Saroyan, *suh ROY uhn,* **William** (1908-1981), was an American writer. He became known for loosely structured, impressionistic plays and stories that praise the common person's ability to live a full, happy life in a world of ugly reality. In the preface to one of his plays, Saroyan wrote: "In the time of your life, live, so that in that good time there shall be no ugliness or death for yourself or for any life your life touches." Saroyan's works show his belief in people's basic innocence. Most are about poor, down-and-out people whose vitality and purity he praises. Some of his works tend to be sentimental rather than objective, especially his portraits of children and of working-class life.



Jerry Bauer, Pix from Publix

William Saroyan

Saroyan was born on Aug. 31, 1908, in Fresno, California. His first book was a collection of stories, *The Daring Young Man on the Flying Trapeze* (1934). Saroyan won the Pulitzer Prize for *The Time of Your Life* (1939), the best of his several plays, but refused to accept the award. He said he disapproved of literary prizes. His other works include a novel, *The Human Comedy* (1943); several autobiographical works, which include *Not Dying* (1963) and *Chance Meetings* (1978); and a collection of nonfiction pieces, *Obituaries* (1979).

Arthur M. Saltzman

Sartre, *SAHR truh,* **Jean-Paul,** *zhahn pawl* (1905-1980), was a French existentialist philosopher who expressed his ideas in novels, plays, and short stories, as well as in theoretical works.

The bare existence of things, especially his own existence, fascinated and horrified Sartre, because there seems to be no reason why anything should exist. In his first novel, *Nausea* (1938), he described the horror and mystery which a man experiences when he considers the unexplainable fact of a thing's existence.

In his chief philosophical work, *Being and Nothingness* (1943), Sartre investigated the nature and forms of *existence* or *being*. He claimed that human existence, which he called "being-for-itself," is radically different from the existence of such inanimate objects as tables, which he called "being-in-itself." Sartre said that only human existence is conscious of itself and of other things. He argued that inanimate objects simply are what they are; however, people are whatever they choose to be. Sartre said that a person is not a coward, for example, in the same simple way that a table is only a table. A person is a coward only by choice. Sartre said that a person, unlike a table, has no fixed character or "essence" that has been assigned. Primarily, people "exist" as beings who must *choose* their own character or "essence." Thus, in his essay *Existentialism and Humanism* (1946), he defined existentialism as the doctrine that, for humankind, "existence precedes essence." See Existentialism.

Wide World

Jean-Paul Sartre

Sartre believed that people are completely free, but are afraid to recognize this freedom and to accept full responsibility for their behavior, which such freedom implies. Thus, people tend to deceive themselves about their true situation. Throughout his philosophical and literary works, Sartre examined and analyzed the varied and subtle forms of *self-deception*.

Sartre criticized Sigmund Freud's psychoanalytic theory of human behavior and offered his own "existential psychoanalysis." Sartre said the ultimate motive for all human behavior is the desire to achieve perfect self-sufficiency by becoming the cause of one's own existence. However, he argued that this goal is self-contradictory and impossible to attain. Therefore, he considered all human activity ultimately futile. As Sartre said: "Man is a useless passion." He identified this idea of perfectly self-sufficient beings who are the cause of their own existence as the traditional idea of God. According to Sartre, each of us wants to become God, and God cannot possibly exist. In the *Critique of Dialectical Reason* (1964), Sartre presented his political and sociological theories, which he considered to be a form of Marxism.

Sartre's plays include *The Flies* (1943), *No Exit* (1944), *Dirty Hands* (1948), and *The Condemned of Altona* (1959). He wrote *The Roads of Freedom,* a sequence of novels including *The Age of Reason* (1945), *The Reprieve* (1945), and *Troubled Sleep* (1949). He applied his psychoanalytic theories in his biographies, *Baudelaire* (1947), *Saint Genet* (1953), and *Flaubert* (1971). *Words* (1963) is an autobiographical account of his youth.

Sartre was born on June 21, 1905, in Paris where he studied at the École Normale Supérieure. During World War II (1939-1945), he fought in the French Army and was active in the French resistance movement. Sartre founded the monthly review *Les Temps Modernes* in 1945 and served as its editor. In 1964, Sartre was awarded the Nobel Prize for literature. However, he refused to accept the award.

Ivan Soll

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Sherman Hines, Masterfile

Grain elevators rise above a field of golden wheat in Togo.

Saskatchewan

Saskatchewan, *sas KACH uh* WAHN, one of the Prairie Provinces of Canada, is the greatest wheat-growing region in North America. Its farmers produce about half of Canada's wheat. The province's vast wheat fields gave it the nickname of *Canada's Breadbasket.* Railroads carry huge loads of the grain to Canadian ports for shipment to all parts of the world. The Saskatchewan Wheat Pool is one of the world's largest marketing cooperatives. Its headquarters are located in Regina, the capital of the province.

Saskatchewan has about two-fifths of the farmland in Canada—more than any other province. Saskatchewan's farms are on its flat southern prairies, where most of the people live. Tall grain elevators rise in the hundreds of towns and villages that dot the fertile plains. More of the land is used to raise wheat than any other crop. In many areas, wheat fields extend to the horizon in all directions. Saskatchewan also ranks among the leading provinces in the production of barley, canola, flaxseed, oats, and rye. The farmers of Saskatchewan raise large numbers of beef cattle as well as grain crops.

Southern Saskatchewan is much more than a rich farming region. Major oil fields were discovered there during the 1950's. These discoveries brought sudden changes to the prairies. Oil wells and drilling rigs became a common sight in the fields of golden wheat. Today, Saskatchewan produces about 15 percent of Canada's petroleum, and is a leading oil producer of North America. Potash mining is a major industry in the province. Large-scale mining of potash, used in fertilizers, began during the early 1960's. In less than 10 years, Saskatchewan had become one of the world's leading producers of potash.

Northern Saskatchewan is rocky and covered with

The contributors of this article are Adrian A. Seaborne, Professor and Head of the Department of Geography at the University of Regina; and Bill Waiser, Professor and Head of the Department of History at the University of Saskatchewan.

Interesting facts about Saskatchewan

WORLD BOOK illustrations by Kevin Chadwick and Steven Brayfield, Artisan-Chicago

"Pile o' Bones" was the original name for the town that became Regina, Saskatchewan's capital. The town was so named because a large number of buffalo skeletons were found nearby. After the town became important, its name was changed to Regina in honor of Queen Victoria. *Regina* is the Latin word for *queen.*

"Pile o' Bones"

Little Manitou Lake, near Watrous, has water three times saltier than any ocean. This high salt content enables swimmers to float with ease.

The first aerial ambulance service in the world began operations in Saskatchewan in February 1946.

The world's largest tomahawk is on display in Tomahawk Park in Cut Knife. The handle is 54 feet (16.5 meters) long and 4 feet (1.2 meters) in diameter at the base. The blade is 18 feet (5.5 meters) long and 9 feet (2.7 meters) in diameter. The tomahawk rests on a concrete tepee that is 30 feet (9.1 meters) high. The structure, unveiled in 1971, symbolizes unity and friendship between the region's native peoples and later European settlers.

World's largest tomahawk

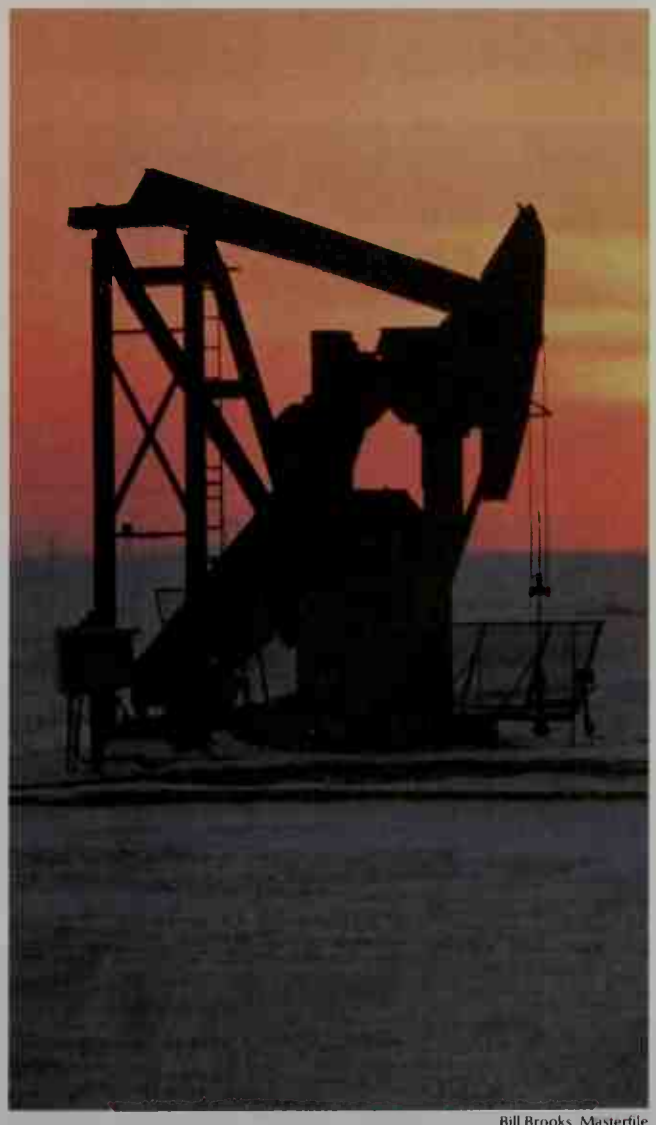
Crombie McNeill, Canadian Government Office of Tourism

Regina, Saskatchewan's capital

forests and lakes. The region has the largest lakes in the province. Deposits of uranium there provide almost all of Canada's uranium and help make the country the world's leading producer of uranium. The region's commercially valuable trees include birch, Eastern larch, fir, jack pine, poplar, and spruce. Caribou, elk, and moose roam the rugged forests. Northern pike, pickerel, trout, and whitefish swim in the sparkling lakes and streams. The people of northern Saskatchewan live in small, scattered communities throughout the region. They earn their living by fishing, mining, trapping, woodcutting, and serving the tourist trade.

The province took its name from the Saskatchewan River, which was named by the Cree Indians. They called the winding river *Kisiskadjewan* or *Kis-is-ska-tchewan,* meaning *fast flowing* or *river that turns around when it runs.*

For Saskatchewan's relationship to the other provinces of Canada, see the articles on Canada; Canada, Government of; Canada, History of; Prairie Provinces.



Bill Brooks, Masterfile

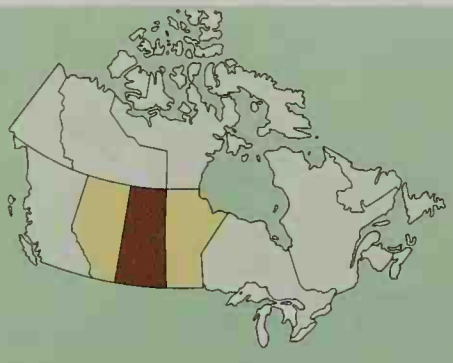
An oil pump on the prairie near Midale

Saskatchewan in brief

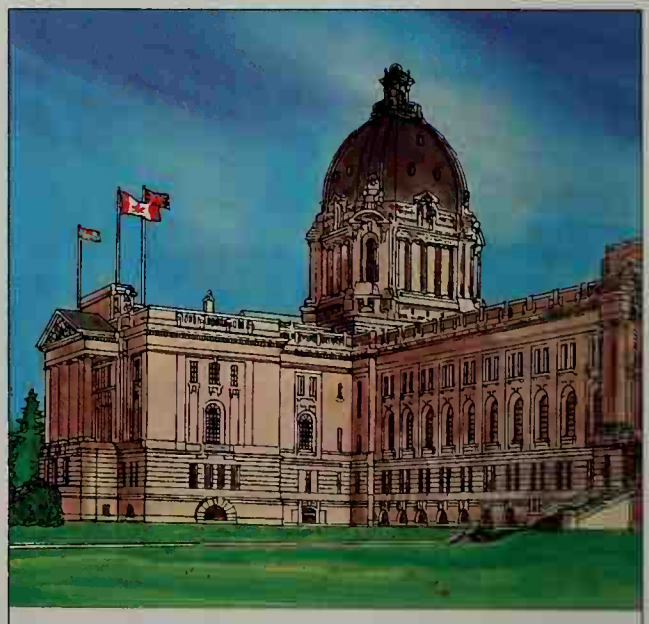
Symbols of Saskatchewan

The provincial flag, adopted in 1969, bears the shield from the coat of arms and the provincial floral emblem, the Western red lily or prairie lily. The green half represents Saskatchewan's forests. The gold portion symbolizes the province's wheat fields. On the shield of the provincial coat of arms, authorized in 1906, the lion stands for Britain. The three golden sheaves represent Saskatchewan's fields of ripening grain.

Provincial flag



Saskatchewan (brown) ranks fifth in size among all the provinces and second among the Prairie Provinces (yellow).



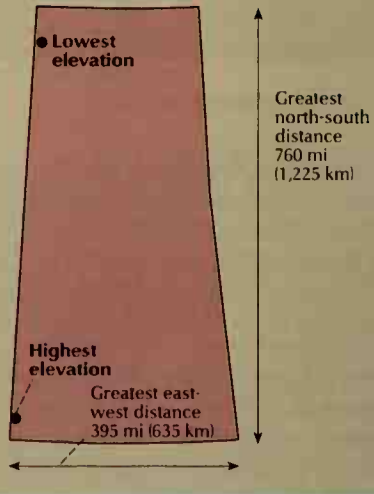
The Legislative Building is in Regina, Saskatchewan's capital since it became a province in 1905. Regina served as capital of the North West Territories from 1883 to 1905.

General information

Entered the Dominion: with Alberta on Sept. 1, 1905, as the 8th and 9th provinces.
Provincial abbreviation: SK (postal).
Provincial motto: *Multis E Gentibus Vires* (From Many Peoples Strength).

Land and climate

Area: 251,866 mi² (652,330 km²), including 31,158 mi² (81,630 km²) of inland water.
Elevation: *Highest*—4,567 ft (1,392 m) above sea level in the Cypress Hills. *Lowest*—700 ft (213 m) above sea level at Lake Athabasca.
Record high temperature: 113 °F (45 °C) at Midale and Yellow Grass on July 5, 1937.
Record low temperature: −70° F (−57 °C) at Prince Albert on Feb. 1, 1893.
Average July temperature: 64 °F (18 °C).
Average January temperature: 0 °F (−18 °C).
Average yearly precipitation: 16 in (40 cm).



Important dates

1690-1692 — Henry Kelsey of the Hudson's Bay Company explored the Saskatchewan region.

1774 — Cumberland House, Saskatchewan's first permanent white settlement, was established.

1882-1883 — The Canadian Pacific Railway was built across the Saskatchewan region.

1905 — Saskatchewan became a province on September 1.

Provincial coat of arms

Provincial seal

Floral emblem
Western red lily
(prairie lily)

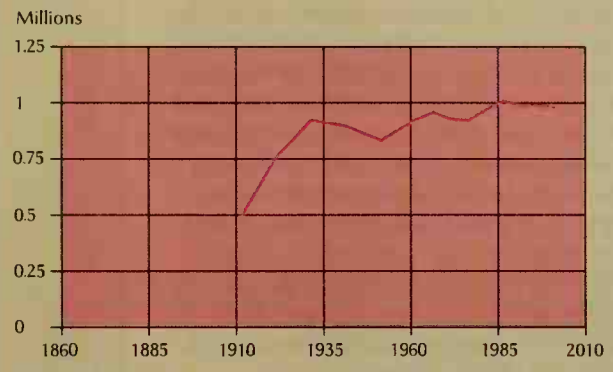
People

Population: 978,933 (2001 census)
Rank among the provinces: 6th
Density: 4 persons per mi² (2 per km²), provinces average 13 per mi² (5 per km²)
Distribution: 64 percent urban, 36 percent rural
Largest cities and towns*

Saskatoon	196,811
Regina	178,225
Prince Albert	34,291
Moose Jaw	32,131
Yorkton	15,107
Swift Current	14,821

*2001 census.
Source: Statistics Canada.

Population trend



Source: Statistics Canada.

Year	Population
2001	978,933
1996	990,237
1991	988,928
1986	1,010,198
1981	968,313
1976	921,323
1971	926,242
1966	955,344
1961	925,181
1951	831,728
1941	895,992
1931	921,785
1921	757,510
1911	492,432

Economy

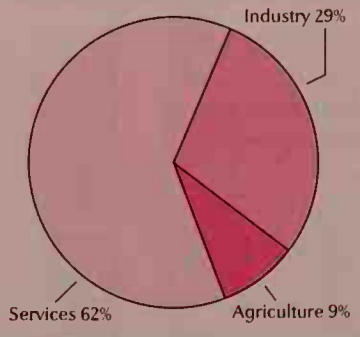
Chief products

Agriculture: wheat, beef cattle, canola, barley.
Manufacturing: food products, printed materials, electrical equipment, chemicals.
Mining: petroleum, potash, uranium, natural gas.

Gross domestic product

Value of goods and services produced in 2000: $33,512,000,000*. *Services* include community, business, and personal services; finance; government; trade; and transportation and communication. *Industry* includes construction, manufacturing, mining, and utilities. *Agriculture* includes agriculture, fishing, and forestry.

* Canadian dollars.
Source: Statistics Canada.



Government

Provincial government

Premier: term of up to 5 years
Members of the Legislative Assembly: 58; terms of up to 5 years

Federal government

Members of the House of Commons: 14
Senators: 6

Sources of information

For information on tourism in Saskatchewan, write to: Tourism Saskatchewan, 1922 Park Street, Regina SK S4P 3V7. Tourism Saskatchewan's Web site at www.sasktourism.com also has useful information. For information on the province's economy, write to: Saskatchewan Bureau of Statistics, Fifth Floor, 2350 Albert Street, Regina, SK S4P 4A6. The bureau's Web site at www.gov.sk.ca/bureau.stats is also helpful. Information on the provincial government can be obtained by writing to: Office of the Clerk of the Legislative Assembly, Room 239 Legislative Building, 2405 Legislative Drive, Regina, SK S4S 0B3. For information on the province's history, write to: Saskatchewan Archives Board, University of Regina, Regina, SK S4S 0A2.

1924 — Farmers set up the Saskatchewan Wheat Pool.

1944 — The voters of Saskatchewan elected the first socialist government in Canada.

1951-1952 — Major petroleum deposits were discovered in Saskatchewan.

1962 — Saskatchewan began a program of tax-supported, free medical care for all residents.

Population. The 2001 Canadian census reported that Saskatchewan had 978,933 people. The province's population had decreased by about 1 percent since the 1996 census, which reported a figure of 990,237.

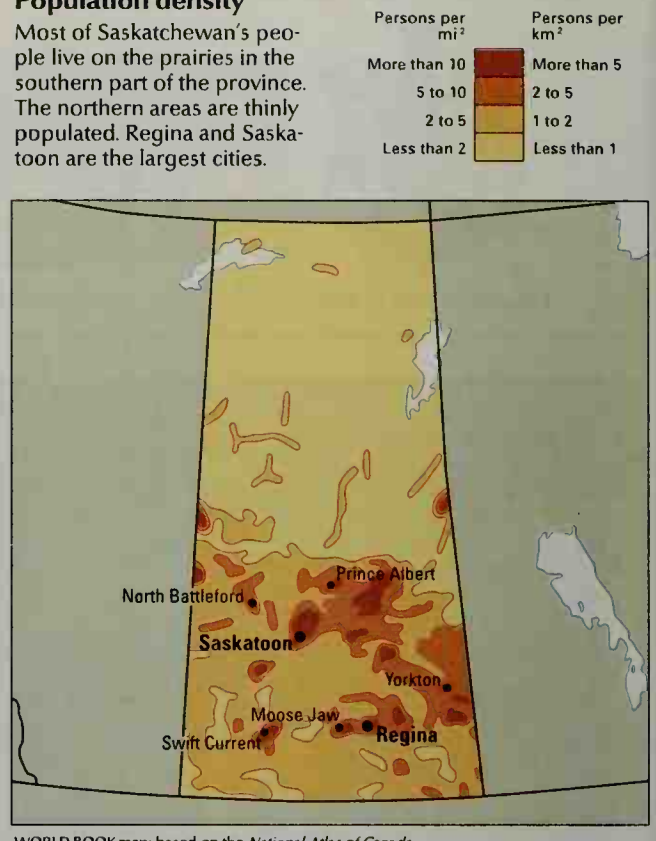
Most of Saskatchewan's people live in the southern part of the province. More than half the people live in cities and towns. Saskatchewan has two Census Metropolitan Areas as defined by Statistics Canada, Regina and Saskatoon. About 40 percent of the province's people live in these two metropolitan areas. Saskatchewan's largest cities, in order of population, are Saskatoon, Regina, Prince Albert, and Moose Jaw. For more information, see the separate articles on the cities and towns of Saskatchewan listed in the *Related articles* at the end of this article.

Over 90 percent of Saskatchewan's people were born in Canada. Most of those born in other countries came from the United Kingdom, the United States, or the Soviet Union. Approximately half of the province's people have some British ancestry. Other large groups, in order of size, include Germans, Ukrainians, and French. There are approximately 52,000 North American Indians. Another 17,000 people have some American Indian ancestry. More than a third of the province's Indians live on reserves. The remaining Indians and several thousand *métis* (pronounced *may TEES* or *may TEE*), people of mixed European and Indian ancestry, live mainly in the province's northern and central regions.

Schools. In 1840, the Church of England and the

Population density

Most of Saskatchewan's people live on the prairies in the southern part of the province. The northern areas are thinly populated. Regina and Saskatoon are the largest cities.



WORLD BOOK map; based on the *National Atlas of Canada*

Saskatchewan map index

Metropolitan areas

Regina 192,800
Saskatoon 225,927

Cities, towns, and other populated places

Abbey ..... 137 ..M 4
Aberdeen ..... 534 ..K 7
Abernethy ..... 213 ..M 9
Ahtahkakoop Indian Reserve ..... 1,099 ..J 6
Air Ronge* ..... 955 ..G 7
Alameda ..... 311 ..O 10
Albertville ..... 132 ..J 7
Alida ..... 117 ..O 11
Allan ..... 679 ..L 7
Alsask ..... 178 ..L 3
Alvena ..... 86 ..K 7
Amsterdam† ..... L 10
Aneroid ..... 56 ..O 6
Annaheim ..... 217 ..K 8
Antler ..... 45 ..O 11
Arborfield ..... 411 ..J 9
Archerwill ..... 215 ..K 9
Arcola ..... 532 ..O 10
Arran ..... 55 ..L 10
Asquith ..... 574 ..K 6
Assiniboia ..... 2,483 ..O 7
Assiniboine Indian Reserve ..... 646 ..N 9
Avonlea ..... 412 ..N 8
Ayleshury ..... 50 ..M 7
Aylsham ..... 106 ..J 9
B-Say-Tah ..... 177 ..M 9
Balcarres ..... 622 ..M 9
Balgonie ..... 1,239 ..N 8
Bangor ..... 48 ..M 10
Battleford ..... 3,820 ..K 5
Beatty ..... 79 ..J 8
Beauval ..... 843 ..G 6
Beechy ..... 295 ..M 6
Belle Plaine* ..... 70 ..N 7
Bellegarde† ..... O 11
Bengough ..... 401 ..O 8
Benson ..... 95 ..O 9
Bethune ..... 380 ..M 7
Beverley† ..... N 5
Bienfait ..... 786 ..O 10
Big Beaver† ..... O 8
Big River ..... 741 ..I 6
Big River Indian Reserve ..... 1,225 ..I 6
Biggar ..... 2,243 ..L 5
Birch Hills ..... 957 ..J 7
Birsay ..... 53 ..M 6
Bjorkdale ..... 229 ..K 9
Bladworth ..... 67 ..L 7
Blaine Lake* ..... 508 ..K 6
Blumenort† ..... N 5
Blumenthal† ..... K 6
Borden ..... 225 ..K 6
Brabant Lake* ..... 66 ..G 8
Bracken ..... 35 ..O 5
Bradwell ..... 156 ..L 7
Bredenbury ..... 354 ..M 10
Brewsters Trailer Court*† ..... J 7
Briercrest ..... 113 ..N 7
Broadview ..... 669 ..N 10
Brock ..... 130 ..L 5
Broderick ..... 83 ..L 6
Brownlee ..... 55 ..M 7
Bruno ..... 571 ..K 7
Buchanan ..... 233 ..L 10
Buena Vista* ..... 397 ..M 8
Buffalo Narrows ..... 1,137 ..F 5
Bulyea ..... 107 ..M 8
Burstall ..... 388 ..M 3
Cabri ..... 483 ..N 5
Cadillac ..... 95 ..O 5
Calder ..... 109 ..M 10
Candle Lake ..... 503 ..I 7
Cando ..... 102 ..K 5
Canora ..... 2,200 ..L 10
Canwood ..... 374 ..J 6
Carievale ..... 254 ..O 11
Carlyle ..... 1,260 ..O 10
Carmel† ..... K 7
Carnduff ..... 1,017 ..O 11
Caron† ..... N 7
Caronport ..... 1,040 ..N 7
Carragana ..... K 9
Carrot River ..... 1,017 ..J 9
Cedoux† ..... N 9
Central Butte ..... 439 ..M 6
Ceylon ..... 105 ..O 8
Chamberlain ..... 89 ..M 7
Chaplin ..... 292 ..N 6
Chelan† ..... K 9
Chitek Lake ..... 174 ..I 5
Chitek Lake Indian Reserve* ..... 756 ..I 5
Chniceland ..... 370 ..J 8
Christopher Lake ..... 230 ..J 7
Churchbridge ..... 796 ..M 10
Clavet ..... 357 ..L 6
Climax ..... 206 ..O 5
Corbin ..... 136 ..J 5
Coderre ..... 50 ..N 7
Codette ..... 237 ..J 8
Cole Bay ..... 161 ..G 5
Coleville ..... 313 ..L 4
Colgate ..... O 9
Collacott Subdivision*† ..... M 10
Colonsay ..... 426 ..L 7
Congress† ..... O 7
Conquest ..... 163 ..L 6
Consul ..... 91 ..O 4
Copper Sand Trailer Park*† ..... N 9
Corning† ..... N 9
Coronach ..... 822 ..O 7
Cote Indian Reserve ..... 582 ..L 10
Craik ..... 418 ..M 7
Crane Valley† ..... O 7
Craven ..... 264 ..M 8
Creelman ..... 85 ..O 9
Creighton ..... 1,556 ..H 10
Crestview Acres*† ..... I 7
Crooked River† ..... J 9
Crutwell† ..... J 7
Crystal Springs† ..... K 7
Cudworth ..... 766 ..K 7
Cumberland House ..... 632 ..I 10
Cupar ..... 602 ..M 8
Cut Knife ..... 556 ..K 4
Dalmeny ..... 1,610 ..K 6
Davidson ..... 1,035 ..M 7
Davin† ..... N 8
Debden ..... 355 ..J 6
Delisle ..... 884 ..L 6
Delmas† ..... J 5
Demaine† ..... M 6
Denare Beach ..... 784 ..H 10
Denholm ..... 79 ..K 5
Denzil ..... 161 ..K 4
Deschambault Lake ..... H 9
Descharme Lake† ..... E 4
Dilke ..... 70 ..M 7
Dinsmore ..... 337 ..M 6
Disley ..... 337 ..N 8
Dodsland ..... 211 ..L 4
Dollard ..... 35 ..O 5
Domremy ..... 135 ..K 7
Doré Lake ..... 27 ..H 6
Dorintosh ..... 125 ..H 5
Drake ..... 248 ..L 8
Drinkwater ..... 80 ..N 8
Dubuc ..... 80 ..M 10
Duck Lake ..... 624 ..K 7
Duff ..... 40 ..M 9
Dunblane† ..... M 6
Dundurn ..... 596 ..L 6
Duval ..... 103 ..M 8
Dysart ..... 210 ..M 8
Earl Grey ..... 292 ..M 8
Eastend ..... 576 ..O 4
Eatonia ..... 474 ..M 4
Ebenezer ..... 147 ..L 10
Edam ..... 429 ..J 5
Edenwold ..... 226 ..M 8
Edgeley† ..... M 9
Elbow ..... 298 ..M 6
Eldersley*† ..... J 8
Elfros ..... 161 ..L 9
Elrose ..... 517 ..M 5
Elstow ..... 97 ..L 7
Endeavour ..... 154 ..K 10
Englefeld ..... 245 ..K 8
Ernfold ..... 50 ..N 6
Erwood† ..... J 10
Esterhazy ..... 2,348 ..M 10
Estevan ..... 10,242 ..O 10
Eston ..... 1,048 ..M 4
Evesham ..... K 4
Eyebrow ..... 136 ..M 7
Fairlight ..... 45 ..N 11
Fenwood ..... 48 ..M 9
Fife Lake ..... 46 ..O 7
Fillmore ..... 246 ..N 9
Findlater ..... 62 ..M 7
Fiske† ..... L 5
Flaxcombe ..... 128 ..L 4
Fleming ..... 95 ..N 11
Flin Flon† ..... 267 ..H 10
Foam Lake ..... 1,218 ..L 9
Forget ..... 40 ..O 10
Fort Qu'Appelle ..... 1,940 ..M 9
Fosston ..... 55 ..K 9
Fox Valley ..... 326 ..N 4
Francis ..... 172 ..N 9
Frenchman Butte† ..... 1,322 ..I 4
Frobisher ..... 149 ..O 10
Frontier ..... 302 ..O 5
Furdale*† ..... K 6
Gainsborough ..... 286 ..O 11
Garrick† ..... J 8
Garson Lake† ..... F 4
Gerald ..... 159 ..M 10
Girvin ..... 25 ..M 7
Gladmar ..... 45 ..O 8
Glaslyn ..... 375 ..J 5
Glen Ewen ..... 158 ..O 10
Glenavon ..... 207 ..N 9
Glenside ..... 63 ..L 6
Glentworth ..... O 6
Glidden ..... M 4
Golden Prairie ..... 56 ..N 4
Goodeve ..... 70 ..M 9
Goodsoil ..... 284 ..H 4
Gordon Indian Reserve ..... 738 ..M 8
Gorlitz† ..... L 10
Govan ..... 274 ..M 8
Grand Coulee ..... 366 ..N 8
Gravelbourg ..... 1,187 ..O 6
Gray† ..... N 8
Grayson ..... 210 ..M 10
Green Acres*† ..... I 5
Green Lake ..... 498 ..H 5
Grenfell ..... 1,067 ..N 9
Griffin† ..... 395 ..O 9
Gronlid† ..... J 8
Gruenthal† ..... K 6
Guernsey ..... 108 ..L 8
Gull Lake ..... 1,016 ..N 5
Hafford ..... 401 ..K 6
Hagen† ..... J 7
Hague ..... 711 ..K 6
Halbrite ..... 109 ..O 9
Handel ..... 25 ..L 5
Hanley ..... 495 ..L 6
Harris ..... 232 ..L 5
Hawarden ..... 57 ..L 6
Hazel Dell† ..... L 9
Hazenmore ..... 71 ..O 6
Hazlet ..... 126 ..N 5
Henribourg† ..... J 7
Hepburn ..... 475 ..K 6
Herbert ..... 812 ..N 6
Herman Brothers Trailer Court*† ..... N 8
Herschel ..... 35 ..L 5
Hitchcock† ..... O 9
Hodgeville ..... 175 ..N 6
Hoey† ..... K 7
Holbein† ..... J 7
Holdfast ..... 190 ..M 7
Hubbard ..... 38 ..M 9
Hudson Bay ..... 1,783 ..J 10
Humboldt ..... 5,161 ..K 8
Hyas ..... 131 ..L 10
Ile-à-la-Crosse ..... 1,268 ..G 5
Imperial ..... 339 ..M 7
Indian Head ..... 1,758 ..N 9
Invermay ..... 284 ..L 9
Ituna ..... 709 ..M 9
Jansen ..... 158 ..L 8
Kamsack ..... 2,009 ..L 10
Kannata Valley* ..... 98 ..M 8
Kawacatoose Indian Reserve ..... L 8
Kelliher ..... 317 ..M 9
Kelvington ..... 1,007 ..K 9
Kenaston ..... 282 ..L 7
Kendal ..... 83 ..N 9
Kennedy ..... 243 ..N 10
Kenosee Lake* ..... 182 ..N 10
Kerrobert ..... 1,111 ..L 4
Killaly ..... 91 ..M 10
Kincaid ..... 161 ..O 6
Kindersley ..... 4,548 ..L 4
Kinistino ..... 702 ..J 8
Kinoosao† ..... E 10
Kipling ..... 1,037 ..N 10
Kisbey ..... 199 ..O 10
Kronau† ..... N 8
Krydor ..... 25 ..K 6

Hudson's Bay Company established the first school in the Saskatchewan region, at the settlement of Cumberland House. Missions and churches provided the only schooling in the region until 1884. That year, the federal government started a system of public education.

Today, Saskatchewan's public schools are governed by local boards of education. They are tax-supported and follow the policies of the provincial department of education. Other types of schools in Saskatchewan include Roman Catholic and Protestant *separate* schools and *francophone* (French-language) schools. Both separate schools and francophone schools receive provincial funds. Children from 7 through 15 years old must attend school. For information on the number of students and teachers in Saskatchewan, see **Education** (table).

Libraries. The first public library in Saskatchewan was established in Regina in 1908. Today, there are public libraries throughout the province. Special libraries include the Legislative Library in Regina and the University of Saskatchewan and University of Regina libraries.

Museums. The Royal Saskatchewan Museum in Regina features galleries that trace the natural history of Saskatchewan and the history of the people who have lived there for the past 10,000 years. The Royal Canadian Mounted Police Centennial Museum and the MacKenzie Art Gallery are in Regina. The Mendel Art Gallery is in Saskatoon. The Western Development Museum, with branches in Moose Jaw, North Battleford, Saskatoon, and Yorkton, has exhibits on the Canadian West. Displays at the Ukrainian Museum of Canada in Saskatoon include costumes and crafts of Ukrainian immigrants.

Universities and colleges

This table lists the universities and colleges in Saskatchewan that grant bachelor's or advanced degrees and are members of the Association of Universities and Colleges of Canada.

Name	Mailing address
Campion College	Regina
Luther College	Regina
Regina, University of	Regina
St. Thomas More College	Saskatoon
Saskatchewan, University of	Saskatoon
Saskatchewan Indian Federated College	*

* Campuses at Prince Albert, Regina, and Saskatoon.

Kurokit	L	9	Medstead	144	J	5	Pelican Narrows	690	G	9	Saltcoats	494	M	10	Tribune	35	O	9
Kyle	478	M	5	Melfort	5,559	J	8	Pelly	303	L	10	Salvador	K	4	Trossachst	O	8	
Lac Vertt	K	8	Melville	4,453	M	10	Pennant	150	N	5	Sandy Bay	1,092	G	10	Tuffnellt	L	9	
Lafleche	446	O	6	Mendham	40	M	4	Pense	533	N	8	Saskatoon	196,811	K	6	Tugaske	116	M	7
Laird	236	K	6	Meota	293	J	5	Penzance	41	M	7	Saulteaux Indian Reserve*	496	J	5	Turnor Lake	155	F	4
Lake Alma	35	O	8	Mervin	146	J	4	Perdue	372	L	6	Sceptre	136	M	4	Turtleford	465	J	4
Lake Lenore	314	K	8	Meyronne	35	O	6	Peter Pond Lake Indian Reserve	F	4	Schoenfeldt	N	5	Tuxford	97	N	7	
La Loche	2,136	F	4	Michel Village	70	F	4	Piapot	55	N	4	Scott	110	K	4	Tyvant	N	9	
Lampman	650	O	10	Midale	496	O	9	Pierceland	449	H	4	Sedley	322	N	9	Unity	2,243	K	4
Lancer	75	M	4	Middle Lake	300	K	7	Pilger	85	K	7	Seekaskootch Indian Reserve	1,834	I	4	Val Marie	134	O	5
Landis	161	K	5	Mikadot	L	10	Pilot Butte	1,850	N	8	Semans	267	L	8	Vanguard	187	O	6
Lang	189	N	8	Milden	196	L	6	Pinehouse Lake	G	6	Senlac	50	K	4	Vanscoy	345	L	6
Langbankt	N	10	Milestone	542	N	8	Pleasantdale	98	K	8	Shaunavon	1,775	O	5	Vawn	61	J	5
Langenburg	1,107	M	10	Ministikwan Indian Reserve	771	I	4	Plenty	147	L	5	Sheho	148	L	9	Veregin	83	L	10
Langham	1,145	K	6	Minton	95	O	8	Plunkett	75	L	7	Shell Lake	185	J	6	Vibank	381	N	9
Lanigan	1,289	L	8	Missinippe	38	G	7	Ponteix	550	O	6	Shellbrook	1,276	J	6	Viceroy	35	O	7
La Ronge	2,727	G	7	Mistatim	104	J	9	Porcupine Plain	820	K	9	Silton	94	M	8	Viscount	272	L	7
Lashburn	783	J	4	Mistawasis Indian Reserve	557	J	6	Prairie Rivert	J	9	Simpson	194	L	7	Vonda	322	K	7
Leader	914	M	4	Mont Nebot	J	6	Preeceville	1,074	L	10	Sintaluta	145	N	9	Wadena	1,412	L	9
Leask	447	J	6	Montmarte	465	N	9	Prelate	164	M	4	Smeaton	178	J	8	Wakaw	884	K	7
Lebret	207	M	9	Moose Jaw	32,131	N	7	Primate	45	K	4	Smiley	55	L	4	Waldeck	333	N	5
Lemberg	306	M	9	Moosomin	2,361	N	11	Prince Albert	34,291	J	7	Snowdent	J	8	Waldheim	889	K	6
Leoville	343	I	6	Morse	248	N	6	Prud'homme	203	K	7	Sonningdalet	K	5	Waldron	15	M	10
Leross	59	M	9	Mortlach	241	N	7	Punnichy	317	L	8	Southend	F	9	Wapachawunak Indian Reserve*	434	F	5
Leroy	413	L	8	Mossbank	379	N	7	Qu'Appelle*	648	N	9	Southend Indian Reserve	696	F	9	Wapella	354	N	10
Leslie	30	L	9	Mozartt	L	9	Quill Lake	439	L	8	Southey	693	M	8	Warman	3,481	K	6
Lestock	226	M	9	Muenster	379	K	8	Quinton	107	L	8	Sovereign	52	L	5	Waseca	169	J	4
Liberty	94	M	7	Naicam	761	K	8	Rabbit Lake	87	J	5	Spalding	261	K	8	Waterhen Indian Reserve	577	H	5
Limerick	146	O	7	Neilburg	366	K	4	Radisson	401	K	6	Speers	71	K	6	Watrous	1,808	L	7
Lintlaw	187	L	9	Nesbit Heights*t	K	10	Radville	735	O	8	Spiritwood	907	J	6	Watson	794	K	8
Lipton	331	M	9	Netherhill	35	L	4	Rama	90	L	9	Spring Valley	N	7	Wawota	538	N	10
Lisieux†	O	7	Neuanlaget	K	6	Rapid View*t	I	5	Springside	525	L	10	Webb	51	N	5			
Livelongt	J	5	Neudorf	304	M	9	Raymore	625	L	8	Spruce Lake*	70	J	4	Weekes	65	K	9	
Lloydminster**	7,840	J	4	Neuhorstt	K	6	Red Earth Indian Reserve	309	J	9	Spy Hill	213	M	11	Weirdale	90	J	7	
Loon Lake	318	I	4	Neville	70	N	5	Red Wing Terrace*t	J	4	Stanley Indian Reserve*	1,248	G	8	Weldon	219	J	8	
Loreburn	143	M	6	New Thunderchild Indian Reserve*	I	4	Redvers	917	O	11	Stanley Mission*	G	8	Welwyn	108	N	11		
Love	71	J	8	Nipawin	4,275	J	8	Regina	178,225	N	8	Star City	482	J	8	Westviewt	M	10	
Lucky Lake	354	M	6	Nokomis	436	L	8	Regina Beach	1,039	M	8	Starlite Trailer Court*t	J	10	Weyakwin	183	I	7	
Lumsden	1,581	N	8	Norquay	485	L	10	Rhein	175	L	10	Stenen	110	L	10	Weyburn	9,534	O	9
Luseland	602	L	4	North Battleford	13,692	K	5	Rheinlandt	K	6	Stewart Valley	101	N	5	Whispering Pines Trailer Court*t	J	7		
MacDowallt	J	7	North Portal	136	O	10	Rhinelandt	N	5	Stockholm	303	M	10	White Bear Indian Reserve	536	O	10		
Macklin	1,330	K	4	Northsidet	J	7	Riceton†	N	8	Storthoaks	99	O	11	White City*	1,013	N	8		
MacNutt	85	M	11	Nut Lake Indian Reserve	K	9	Richlea	M	5	Stoughton	720	O	9	White Fox	436	J	8		
Macoun	170	O	9	Odessa	242	N	9	Richmound	193	N	4	Strasbourg	760	M	8	Whitewood	947	N	10
Macrorie	96	M	6	Ogema	292	O	8	Ridgedale	85	J	8	Strongfield	42	M	6	Wilcox	322	N	8
Maidstone	995	J	4	Onion Lake†	I	4	Riverhurst	143	M	6	Sturgeon Lake Indian Reserve*	873	J	7	Wilkie	1,282	K	5	
Major	81	L	4	Ormistont	O	7	Rocanville	887	N	11	Sturgis	627	L	10	Willow Bunch	395	O	7	
Makwa	101	J	4	Osler	823	K	6	Roche Percee	162	O	10	Success	51	N	5	Willowbrook	47	M	10
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Manor	305	O	10	Outlook	2,129	L	6	Rokeby*t	M	10	Sylvaniat	K	8	Wishart	121	L	9		
Maple Creek	2,270	N	4	Oxbow	1,132	O	10	Rose Valley	395	K	9	Tadmoret	L	10	Wolseley	766	N	9	
Marcelin	167	J	6	Paddockwood	171	J	7	Rosenhoft	N	5	Tantallon	110	N	10	Wood Mountain	40	O	6	
Marchwellt	M	11	Palmer	20	O	7	Rosetown	2,471	L	5	Tessier	30	L	6	Woodrow	15	O	6	
Marengo	47	L	4	Pambrunt	N	6	Rosthern	1,504	K	7	Theodore	381	L	9	Wroxton	M	10		
Margo	106	L	9	Pangman	255	O	8	Rouleau	434	N	8	Timber Bay	108	I	8	Wymark†	N	5	
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Maymont	164	K	5				St. Louis	474	J	7					Zelma	40	L	7	
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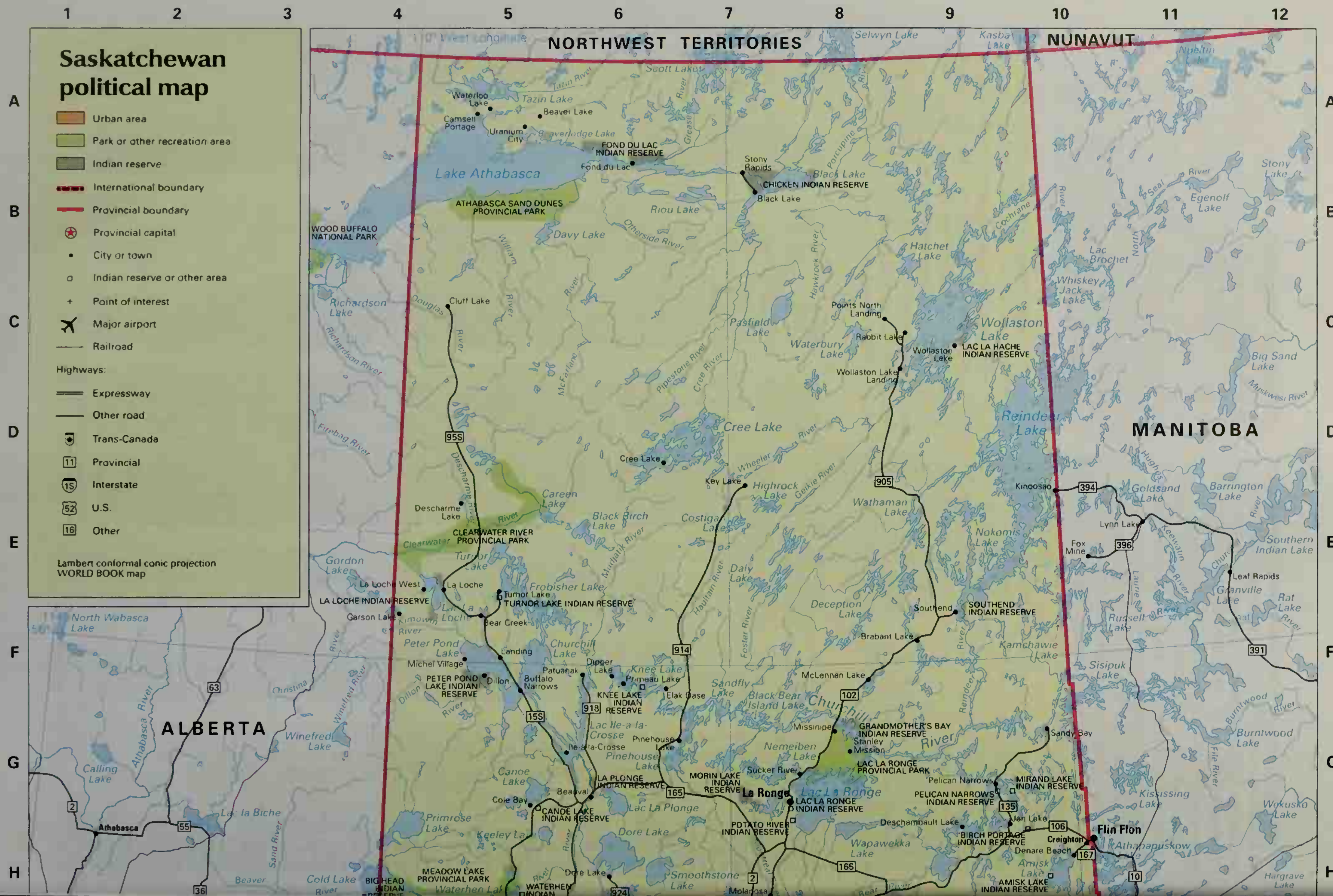
McCordt	O	6					St. Walburg	672	I	4									
McLean*	271	N	8																
McTaggart	126	O	9																
Meacham	90	L	7																
Meadow Lake	4,582	I	5																
Meath Park	204	J	7																

*Does not appear on map, key shows general location.
†Unincorporated place.
‡City on Saskatchewan-Manitoba border; total population, 6,267.

**City on Saskatchewan-Alberta border; total population, 20,988.
Source: 2001 census.



Saskatchewan political map
Urban area
Park or other recreation area
Indian reserve
International boundary
Provincial boundary
Provincial capital
City or town
Indian reserve or other area
Point of interest
Major airport
Railroad
Highways:
Expressway
Other road
Trans-Canada
Provincial
Interstate
U.S.
Other
Lambert conformal conic projection
WORLD BOOK map
NORTHWEST TERRITORIES
NUNAVUT
MANITOBA
ALBERTA
Lake Athabasca
ATHABASCA SAND DUNES PROVINCIAL PARK
WOOD BUFFALO NATIONAL PARK
FOND DU LAC INDIAN RESERVE
Fond du Lac
Uranium City
Camsell Portage
Waterloo Lake
Tazin Lake
Beaver Lake
Stony Rapids
Black Lake
CHICKEN INDIAN RESERVE
Cluff Lake
Cree Lake
Key Lake
Highrock Lake
Wollaston Lake
LAC LA HACHE INDIAN RESERVE
Points North Landing
Rabbit Lake
Wollaston Lake Landing
Reindeer Lake
Kinoosao
Southend
SOUTHEND INDIAN RESERVE
Brabant Lake
McLennan Lake
Missinipe
GRANDMOTHER'S BAY INDIAN RESERVE
Stanley Mission
LAC LA RONGE PROVINCIAL PARK
La Ronge
LAC LA RONGE INDIAN RESERVE
POTATO RIVER INDIAN RESERVE
MORIN LAKE INDIAN RESERVE
Sucker River
Pinehouse
Elak Dase
Primeau Lake
KNEE LAKE INDIAN RESERVE
Dipper Lake
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Buffalo Narrows
Ile-a-la-Crosse
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Beauval
CANOE LAKE INDIAN RESERVE
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Jan Lake
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BIRCH PORTAGE INDIAN RESERVE
Denare Beach
Creighton
Flin Flon
AMISK LAKE INDIAN RESERVE
Lynn Lake
Fox Mine
Leaf Rapids
Athabasca
North Wabasca Lake
Calling Lake
Lac la Biche
Winefred Lake
Cold Lake

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SASKATCHEWAN
MANITOBA
MONTANA
NORTH DAKOTA
CANADA
UNITED STATES
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St. Albert
Vermilion
Lloydminster
Camrose
Wetaskiwin
Wainwright
Drumheller
Hanna
Brooks
Medicine Hat
Taber
Lethbridge
Saskatoon
North Battleford
Battleford
Prince Albert
Nipawin
The Pas
Melfort
Tisdale
Humboldt
Swan River
Kamsack
Yorkton
Melville
Esterhazy
Regina
Moose Jaw
Swift Current
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Kindersley
Rosetown
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Unity
Kerrobert
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Leader
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Ponteix
Shaunavon
Gull Lake
Herbert
Outlook
Watrous
Davidson
Lanigan
Wynyard
Canora
Dauphin
Roblin
Russell
Churchbridge
Langenburg
Whitewood
Broadview
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Grenfell
Carlyle
Redvers
Oxbow
Bienfait
Crosby
Bottineau
Lumsden
Indian Head
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Balcarres
Foam Lake
Kelvington
Wadena
Preeceville
Hudson Bay
Carrot River
Porcupine Plain
Naicam
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Rosthern
Hague
Cudworth
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Grasslands National Park
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Duck Mountain Provincial Park
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Moose Mountain Provincial Park
Pike Lake Provincial Park
Saskatchewan Landing Provincial Park
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Lake Winnipegosis
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Clearwater Lake
Red Deer Lake
Pelican Lake
Swan Lake
Meadow Lake
Loon Lake
Makwa
Waskesiu Lake
Montreal Lake
Pine Bluff
Cumberland House
Squaw Rapids
Ravendale
Love
White Fox
Chemong
Codette
Carrot River
Moose Range
Aylsham
Arborfield
Armley
Zenon Park
Ridgedale
Brooksby
Eldersley
Peesane
Erwood
Mistatim
Prairie River
Clemenceau
Hudson Bay
Kinistino
Beatty
Star City
Waterhen Lake
Crystal Springs
Ethelton
Pathlow
Goburn
Sylvania
McKague
Silver Park
Porcupine Plain
Barford
Chelan
Weekes
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Archerwell
Perigord
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Danbury
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Norquay
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Togo
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Ebenezer
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Theodore
Yorkton
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Melville
Langenburg
Esterhazy
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Whitewood
Wolseley
Grenfell
Kipling
Moosomin
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Carlyle
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Lake Newell
Lake Winnipegosis
Cedar Lake
Clearwater Lake
Red Deer Lake
Pelican Lake
Swan Lake
North
1 2 3 4 5 6 7 8 9 10 11 12
0 10 25 50 100 150 200 250 300 350 400 450 500 550 Miles
0 10 25 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 Kilometers

Saskatchewan's landscape includes beaches, forested highlands, lakes, river valleys, and vast woodlands. These areas provide plenty of opportunities to enjoy outdoor recreational activities such as bird watching, camping, canoeing, hiking, and horseback riding.

Northern Saskatchewan offers some of the best hunting and fishing in North America. Sports enthusiasts fly there to hunt bear and moose or to fish for grayling, northern pike, trout, and walleye.

In southern Saskatchewan, the sparkling lakes of the Qu'Appelle Valley have popular summer resorts that feature boating, fishing, golfing, and swimming. Various historic parks and monuments honor battlefields and forts from Saskatchewan's colorful past. Many markers identify early trails used by hunters, fur traders, and patrols of the old North-West Mounted Police. Communities around Saskatchewan hold rodeos and a variety of festivals. Indian powwows also take place.

Al Harvey, Masterfile

Prince Albert National Park in central Saskatchewan

Places to visit

Following are brief descriptions of some of Saskatchewan's many interesting places to visit:

Mendel Art Gallery and Civic Conservatory, in Saskatoon, features art from western Canada and seasonal floral displays.

National Doukhobour Heritage Village, in Veregin, focuses on Canada's Doukhobour immigrants. The Doukhobours, a people devoted to work and a peaceful life, began fleeing their native Russia in 1899 to avoid persecution.

Royal Canadian Mounted Police Training Academy, in Regina, is the Mounties' training headquarters. It has a museum containing historic documents, uniforms, and weapons.

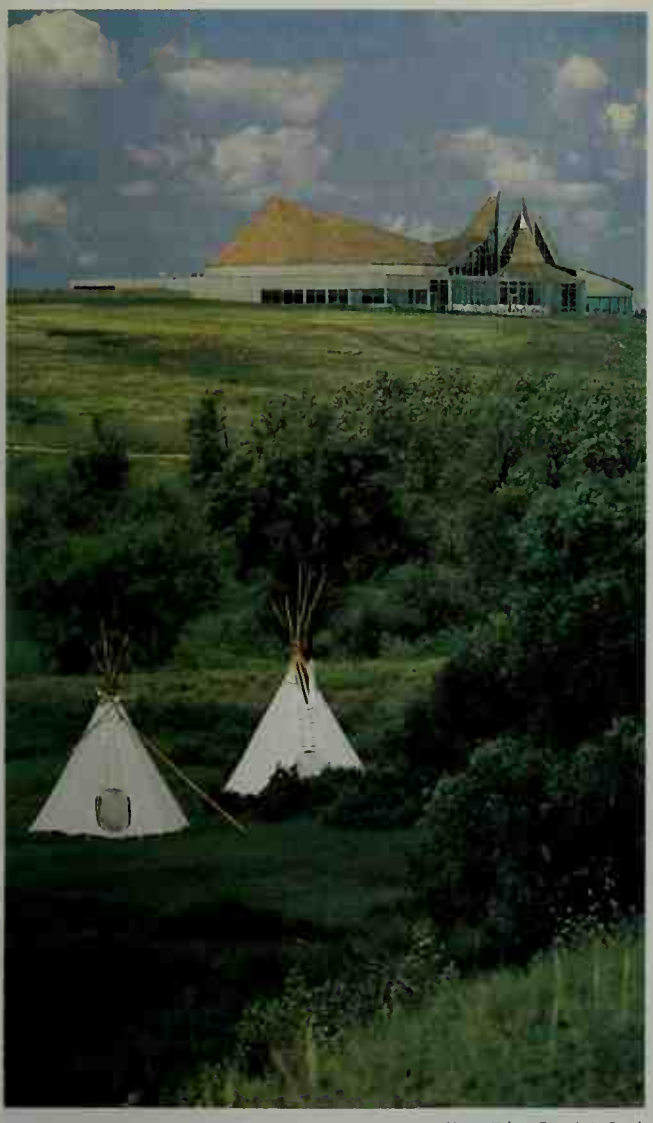
Saskatchewan Science Centre, in Regina, has permanent hands-on science exhibits, live demonstrations, and visiting exhibits. Its Kramer IMAX Theatre shows films on a screen seven stories high.

T-Rex Discovery Centre, in Eastend, offers visitors a chance to see dinosaur bones and witness scientists at work on dinosaur digs.

Wanuskewin Heritage Park, in Saskatoon, recalls the lives of Plains Indians. People can visit early encampment sites, learn to build a tepee, and witness archaeological digs. The park has a museum, a theater, an art gallery and more.

National parks and sites. Prince Albert National Park is in central Saskatchewan. Grasslands National Park lies in the southwest. Saskatchewan has six national historic sites. See **Canada** (National Park System).

Provincial parks. Saskatchewan has 24 provincial parks, 9 provincial historic parks, an interprovincial park, and about 100 regional parks in the southern and central parts of the province. For information, contact Tourism Saskatchewan, 1922 Park Street, Regina, SK S4P 3V7. The Web site of Saskatchewan Environment and Resource Management at www.serm.gov.sk.ca/parks also has useful information on provincial parks in Saskatchewan.



Henry Kalen, Canada in Stock

Wanuskewin Heritage Park in Saskatoon

Annual events

January-June

Prince Albert Winter Festival (February); Yorkton Short Film and Video Festival (May); Northern Saskatchewan International Children's Festival in Saskatoon (June); Western Canada Farm Progress Show in Regina (June); Frontier Days in Swift Current (June); Saskatchewan Jazz Festival in Saskatoon (June); Shakespeare on the Saskatchewan in Saskatoon (July-August).

July-December

Saskatchewan Air Show in Moose Jaw (July); Flatland Music Festival in Regina (July); Saskatchewan Handcraft Festival in Battleford (July); RCMP Sunset Retreat Ceremonies in Regina (July-August); Buffalo Days in Regina (July-August); Yorkton Threshermen's Show and Seniors' Festival (August); World Bunnock Championship Challenge in Macklin (August); International Fringe Festival in Saskatoon (August); Canadian Western Agribition in Regina (November); Sundog Handcraft Fair in Saskatoon (November-December).

Prince Albert Winter Festival

Sleigh race at the Prince Albert Winter Festival

Tourism Saskatchewan

Mounties on parade at the Royal Canadian Mounted Police Training Academy

Land regions. Saskatchewan has four land regions: (1) the Canadian Shield, (2) the Manitoba Lowland, (3) the Saskatchewan Plain, and (4) the Alberta Plain. The lowland and the plain regions form part of the Western Interior Plains, the Canadian section of the North American Great Plains.

The Canadian Shield is a vast, horseshoe-shaped region that covers almost half of Canada and dips into the United States. This rough area, made up of ancient granites and other rocks, covers most of the northern half of Saskatchewan. It has deposits of copper, uranium, zinc, and many other minerals. The region also has the largest lakes of the province. Pine and spruce forests cover most of the land. See **Canadian Shield**.

The Manitoba Lowland extends westward from the Manitoba border for about 90 miles (140 kilometers). Rocky soils and poor drainage make the land generally unsuitable for farming. The region has large areas of marshes and forests, and many lakes and rivers.

The Saskatchewan Plain is mostly level land, broken by some low hills. Most of the region is from 1,700 to 2,000 feet (518 to 610 meters) above sea level. Commercial forests grow in the northern part of the plain. To the south are grasslands with scattered groves of trees that give way to almost treeless plains. Saskatchewan's chief farming area lies in this region.

The Alberta Plain is separated from the Saskatchewan Plain by a hilly belt called the *Missouri Coteau* or *Missouri Escarpment*. Most of the region is rolling, treeless land, 2,000 to 3,000 feet (610 to 910 meters) high, with deep river valleys. The highest point in the province rises to 4,567 feet (1,392 meters) in the Cypress Hills, a wooded plateau in the southwest. The region's northern strip extends into the commercial forest belt.

Rivers and lakes. Southern Saskatchewan has few important rivers and lakes. The most important river is the Saskatchewan River, 1,205 miles (1,939 kilometers) long. It is fed by waters from the Rocky Mountains in Alberta. Its major branches in the province are the North Saskatchewan and South Saskatchewan rivers. The Assiniboine River and its main branches, the Qu'Appelle and Souris, drain southeastern Saskatchewan. The largest lakes in the south are Old Wives and Quill lakes, which are shallow and salty, and Last Mountain Lake.

WORLD BOOK map

Land regions of Saskatchewan

John de Visser, Masterfile

Flat, treeless plains extend to the horizon in southern Saskatchewan. These vast prairies are well suited for growing wheat and other grain crops, and for grazing cattle. The land contrasts sharply with the rugged, wooded landscape of the northern part of the province.

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Lake Dielenbaker E 4
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Lodge Creek F 2
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Montreal Lake D 5
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Saskatchewan
terrain map
National or provincial park boundary
Boundary
Provincial capital
City or town
Elevation above sea level
Dam
WORLD BOOK map
NORTHWEST TERRITORIES
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ALBERTA
MANITOBA
SASKATCHEWAN
MONTANA
NORTH DAKOTA
CANADA
U.S.
Lake Athabasca
Reindeer Lake
Churchill River
Saskatchewan River
Athabasca River
Fort McMurray
Athabasca
Lac La Biche
Lac La Loche
Lac Île-à-la-Crosse
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Elk Island Nat'l Park
Vermilion R.
Blackfoot Hills
2,500 ft. (762 m)
Battle River
Buffalo Lake
Neutral Hills
3,000 ft. (914 m)
Sullivan Lake
Sounding Creek
Medicine Hat
Cypress Hills
4,810 ft. (1,466 m)
Etzikom Coulée
Milk River
Boundary Plateau
Cypress Hills Prov. Park
4,567 ft. (1,392 m)
Highest point in Saskatchewan
Frenchman River
Battle Creek
Swiftcurrent Cr.
Great Sand Hills
The Middle Sand Hills
Red Deer River
Bow River
Eagle Creek
Swift Current
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Pinto Butte
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Grasslands Nat'l Park
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Gardiner Dam
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Touchwood Hills
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Saskatoon
Prince Albert
North Battleford
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Meadow Lake Prov. Park
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Lac La Ronge
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Carrot River
Pasquia Hills
Wildcat Hill
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Cedar Lake
Lake Winnipegosis
Dawson Bay
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Moose Mtn
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Antler River
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Grassberry
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Doré Lake
Primrose Lake
Canoe Lake
Cold Lake
Winefred Lake
Peter Pond Lake
Churchill Lake
Christina River
Owl R.
Turnor Lake
Frobisher L.
Wasekamio L.
Black Bird L.
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Foster R.
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Geike River
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Keewatin
1,228 ft. (374 m)
Highrock Lake
Burntwood Lake
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Reed L.
Otter Lake
Sandfly L.
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Nemeiben Lake
Egg L.
Lac La Plonge
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Waterbury Lake
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MacFarlane River
William River
Athabasca Sand Dunes Provincial Park
Black Lake
Riou Lake
Fond-du-Lac
Fond du Lac
Tazin Lake
Tazin River
Scott Lake
Selwyn Lake
Porcupine River
Kasmere Lake
Cochrane River
Egenolf Lake
Lac Brochet
Brochet
Whiskey Jack Lake
Wollaston Lake
Big Sand Lake
Hughes Barrington Lake
56° North Latitude
102° West Longitude
0 100 200 300 400 500 Miles
0 100 200 300 400 500 600 700 Kilometers

John C. Whyte, Hot Shots

A sparkling blue lake forms part of a chain of scenic lakes in the Qu'Appelle River Valley of southeastern Saskatchewan. Low hills and scattered groves of trees surround the lakes.

Gardiner Dam, built on the South Saskatchewan River near Outlook, created a 170-square-mile (440-square-kilometer) reservoir called Lake Diefenbaker. It provides water to irrigate 500,000 acres (200,000 hectares) of farmland as well as hydroelectric power.

Northern Saskatchewan is less dry, and has most of the rivers and lakes. The Churchill River system and the rivers flowing into Lake Athabasca drain northern Saskatchewan. Many northern rivers are actually narrow lakes that connect with each other. Lake Athabasca, the largest of Saskatchewan's many lakes, covers 3,064 square miles (7,935 square kilometers). About a third of this lake extends into Alberta. Other large lakes include Reindeer, Wollaston, La Ronge, and Cree lakes.

Plant and animal life. Forests cover about 91,000 square miles (235,000 square kilometers) in Saskatchewan—about a third of the province's total area, including inland water. About 40,000 square miles (104,000 square kilometers) are available for logging. These forests extend across the province in a belt about 150 miles (241 kilometers) wide, most of it north of Prince Albert. The most valuable trees in this belt are birch, jack pine, poplar, and spruce. Others include balsam fir and larch.

The provincial flower, called the Western red lily or prairie lily, grows throughout the plains, as do cactuses, crocuses, vetches, and violets. Shrubs, such as chokecherries, hazels, and wild roses, grow in the woodlands.

Elk, moose, and Barren Ground caribou live mainly in woodlands of the central and northern regions. Deer

Average monthly weather

Regina

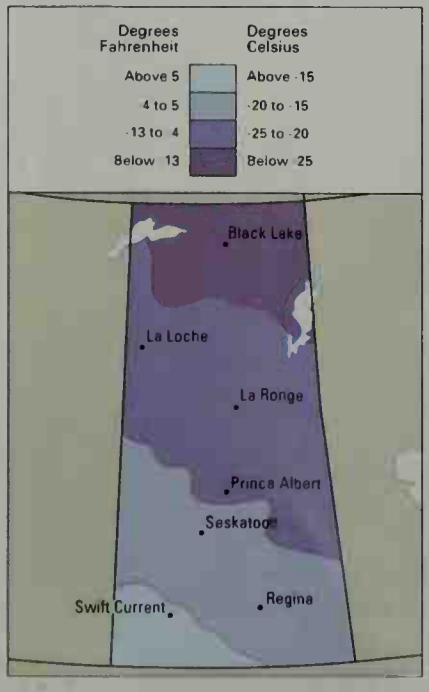
	Temperatures F° High	Low	Temperatures C° High	Low	Days of rain or snow
Jan.	12	−8	−11	−22	11
Feb.	18	−2	−8	−19	9
Mar.	30	10	−1	−12	8
Apr.	52	28	11	−2	7
May	66	39	19	4	10
June	73	48	23	9	11
July	79	54	26	12	10
Aug.	79	52	26	11	9
Sept.	66	41	19	5	8
Oct.	54	28	12	−2	6
Nov.	32	12	0	−11	8
Dec.	18	−2	−8	−19	11

Saskatoon

	Temperatures F° High	Low	Temperatures C° High	Low	Days of rain or snow
Jan.	10	−9	−12	−23	11
Feb.	16	−2	−9	−19	9
Mar.	28	10	−2	−12	9
Apr.	50	28	10	−2	7
May	64	41	18	5	9
June	73	48	23	9	12
July	77	54	25	12	11
Aug.	77	50	25	10	9
Sept.	64	41	18	5	8
Oct.	52	28	11	−2	6
Nov.	30	12	−1	−11	8
Dec.	14	−4	−10	−20	11

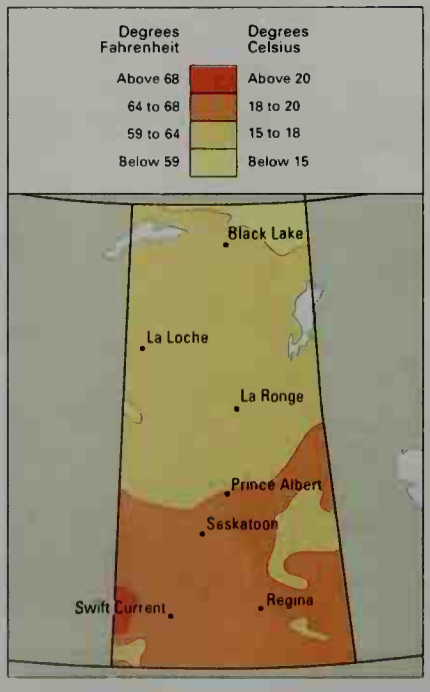
Average January temperatures

Saskatchewan has long, cold winters. The southwest section of the province has the mildest wintertime temperatures.



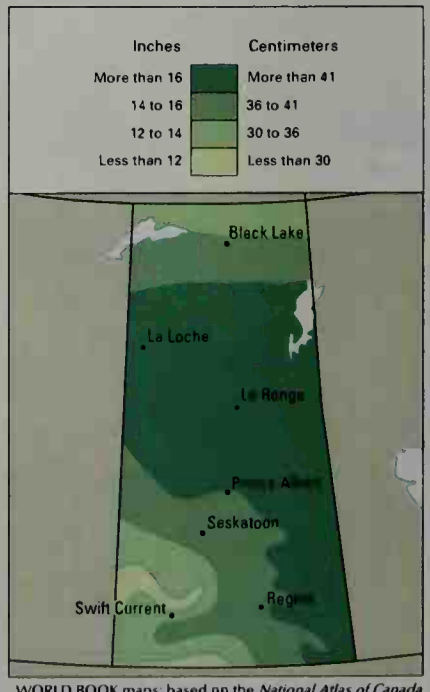
Average July temperatures

Summers in the province are short and mild. The south generally is warmer than the rest of Saskatchewan.



Average yearly precipitation

Saskatchewan is dry with only slight variations in precipitation. The southwest and far north are the driest areas.

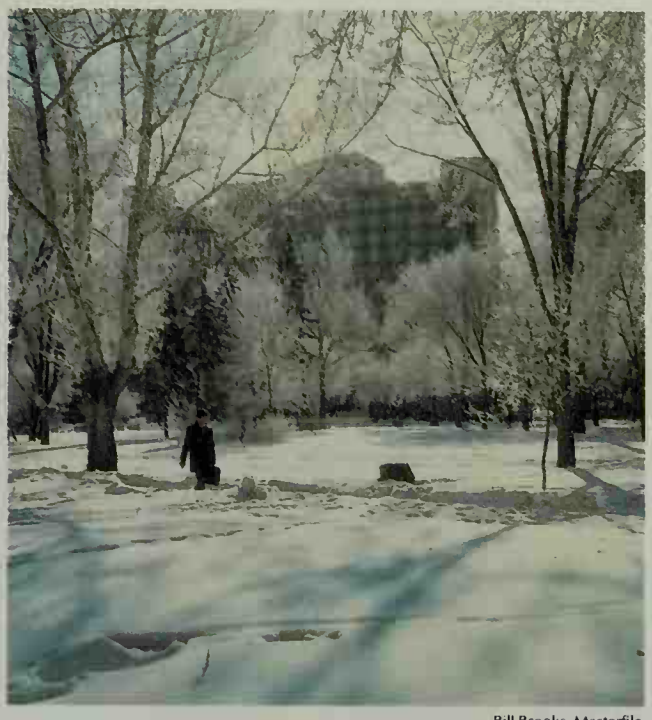


WORLD BOOK maps, based on the *National Atlas of Canada*

and rabbits may be seen throughout the province. Fur-bearing animals in the forests include bears, beavers, minks, otters, and wolves. Pronghorns and coyotes roam the southwestern plains. Game birds, especially ducks and geese, nest along the lakes. Partridges, pheasants, and ruffed and sharp-tailed grouse live in the southern Saskatchewan Plain. The lakes and rivers have pickerel, pike, trout, tullibee, and whitefish. Grayling live chiefly in the northern waters.

Climate. Saskatchewan has short, warm summers and cold winters. Average January temperatures range from −17 °F (−27 °C) in the north to 9 °F (−13 °C) in the south. Warm chinook winds may raise winter temperatures in the south as much as 20 degrees Fahrenheit (11 degrees Celsius) within a few hours (see Chinook). Average July temperatures vary between 61 °F (16 °C) in the north and 67 °F (19 °C) in the south. The lowest temperature recorded in Saskatchewan, −70 °F (−57 °C), occurred in Prince Albert on Feb. 1, 1893. Midale and Yellow Grass had the highest temperature, 113 °F (45 °C), on July 5, 1937.

Saskatchewan's annual *precipitation* (rain, melted snow, and other forms of moisture) ranges from 14 to 19 inches (35 to 49 centimeters) in most places. Annual snowfall in the province varies from 41 inches (105 centimeters) in the south to 85 inches (215 centimeters) in the north.



Bill Brooks, Masterfile

Snow blankets Victoria Park in Regina in winter. Saskatchewan has long, cold winters. Annual snowfall averages as much as 85 inches (215 centimeters) in some parts of the province.

Economy

In early days, the economy of the Saskatchewan region was based on the fur trade. European settlers started trading with Indian tribes in the late 1600's. Grain farming and ranching became important in the province during the late 1800's. Mining became important after large deposits of petroleum, potash, and uranium were discovered in the 1950's. Today, service industries account for the largest part of Saskatchewan's *gross domestic product* (GDP)—the total value of goods and services produced in the province annually.

Agriculture and mining still play a major role in the Saskatchewan economy. Agriculture provides a larger share of the GDP in Saskatchewan than it does in any other province. The province continues to be an important producer of petroleum, potash, and uranium.

Natural resources of Saskatchewan include fertile soils and valuable minerals.

Soil. The rich grassland soils of southern Saskatchewan are probably the province's chief natural resource. These soils lie in parallel zones that slant from northwest to southeast. The far southwestern zone has brown soils that produce good crops when enough rain falls. But the region is dry, and much of it is used for raising cattle. Rainfall increases to the northeast, where dark brown and black soils are found. These soils in the south-central part of Saskatchewan are the most fertile in the province. The northern forest region has less fertile, gray soils.

Minerals. The Canadian Shield of northern Saskatchewan has varied mineral deposits. Uranium, the most important, is mined in the Lake Athabasca and Wollaston Lake regions. Other mineral deposits in northern Saskatchewan include copper, gold, silver, and zinc.

In the south and south-central regions, the most important mined products are potash, petroleum, coal, and sodium sulfate. Saskatchewan is the largest potash producer in the world, accounting for nearly 25 percent of the world's total. The province also has about 1 billion barrels of petroleum reserves. Sodium sulfate is used to make paper and detergents. The southern part of Saskatchewan also has deposits of salt and natural gas.

Production and workers by economic activities

Economic activities	Percent of GDP* produced	Employed workers	
		Number of people	Percent of total
Community, business, & personal services	21	174,600	36
Finance, insurance, & real estate	16	26,600	6
Mining†	14	15,900	2
Wholesale & retail trade	10	76,300	16
Transportation & communication	9	46,100	7
Agriculture	9	62,100	13
Manufacturing	7	29,200	7
Government	6	26,700	6
Construction	5	24,000	6
Utilities	3	3,600	†
Total	100	485,100	100

*GDP = gross domestic product, the total value of goods and services produced in a year
†Employment figures include fishing and forestry.
Figures are for 2000.
Source: Statistics Canada.

Economy of Saskatchewan

This map shows the economic uses of land in Saskatchewan and where the leading farm, mineral, and forest products are produced. Major manufacturing centers are shown in red.

Government of Saskatchewan

Slabs of beef hang in a meat-processing plant in Moose Jaw. The raising of beef cattle is a major farm activity, and meat packing is a leading manufacturing activity in Saskatchewan.

Government of Saskatchewan

A huge potash-mining complex operates near Lanigan. The production of potash ranks second only to petroleum output among the leading mining activities in Saskatchewan.

Service industries account for the largest part of Saskatchewan's gross domestic product. Service industries are concentrated in the province's major cities.

Community, business, and personal services form the most important group of service industries in Saskatchewan, in terms of both gross domestic product and employment. This industry group consists of such activities as education, health care, data processing, legal services, and the operation of hotels and repair shops. The University of Saskatchewan in Saskatoon and the University of Regina employ many people.

Finance, insurance, and real estate form the second most important service industry in Saskatchewan in terms of the gross domestic product. Real estate is the most important part of this industry because of the large sums of money involved in the selling and leasing of property. Regina is the province's chief financial center.

Ranking next among Saskatchewan's service industries are (1) wholesale and retail trade and (2) transportation and communication.

Wholesale trade consists of buying goods from producers and selling the goods to other businesses. The wholesale trade of farm equipment, food products, and minerals is important in Saskatchewan. Retail trade involves selling goods directly to consumers. Major types of retail establishments in the province include automobile dealerships, discount stores, and food stores. The trade industry is the province's second largest employer.

Freight trains are a vital part of the transportation industry because they carry cattle, wheat, minerals, and other commodities to markets. Oil and gas pipelines are also an important transportation method. Many trucking firms operate in Regina and Saskatoon. Telephone companies are the most important part of the communications industry. More information about transportation and communication appears later in this section.

Government ranks next among the service industries. Provincial government activities are based in Regina. A large military air base in Moose Jaw is one of the largest employers in Saskatchewan.

Mining. Petroleum is Saskatchewan's most important mined product. The province has four major petroleum-producing regions: Estevan-Weyburn in the southeast; Swift Current and Kindersley, both in the southwest; and Lloydminster in the west-central part of Saskatchewan. Approximately 60 percent of the petroleum mined in Saskatchewan is exported to the United States. Much of the remainder of Saskatchewan's production is sold in

the eastern provinces of Canada.

Potash is the province's second-ranking mined product. Potash is a potassium salt that is a major ingredient in some fertilizers. Saskatchewan is North America's leading producer of potash. Saskatchewan's potash mines are located in the southern third of the province.

Natural gas ranks third in value among Saskatchewan's mined products. Natural gas is produced primarily in the southwestern part of the province. Pipelines carry the gas to cities and industrial areas.

Uranium is the next most important source of mining income in Saskatchewan. The province is one of the world's leading uranium-producing regions. The Wollaston Lake area in northeast Saskatchewan and the Key Lake area in north-central Saskatchewan produce most of the province's uranium. Saskatchewan's other mined products include coal, gold, salt, sodium sulfate, and sand and gravel.

Agriculture. Saskatchewan has about 66 million acres (27 million hectares) of farmland—more than any other province, and about 40 percent of Canada's total. Saskatchewan has about 60,000 farms. They cover most of the land west and south of the Manitoba Lowland, or almost half the province's total land area. Each year, some of the cropland is left *fallow* (not planted) to accumulate moisture and control weeds.

Wheat is Saskatchewan's leading agricultural product. Wheat accounts for about a third of the province's farm income, and Saskatchewan raises about half of Canada's wheat. Wheat fields cover much of the southern part of the province. Production of the crop is especially heavy in south-central Saskatchewan.

Canola and barley are also major sources of farm income in Saskatchewan. Saskatchewan is North America's leading producer of canola, which is used to make vegetable oil. Saskatchewan also ranks first among the leading barley-growing provinces and states. Barley is used mainly for livestock feed. Barley and canola production is heaviest in the area between Lloydminster and Yorkton. Other farm products include flaxseed, hay, lentils, mustard seed, oats, and peas.

The raising of beef cattle also contributes significantly to Saskatchewan's economy. The largest cattle-raising areas are near Lloydminster, Moosomin, Swift Current, and Yorkton. But almost all parts of southern Saskatchewan have some cattle. Saskatchewan farmers also raise large numbers of dairy cattle and hogs, especially in the area just east of Saskatoon.

Manufacturing. Goods manufactured in Saskatchewan have a *value added by manufacture* of about 2.9 billion Canadian dollars yearly. This figure represents the difference between the value of raw materials and the value of the finished products manufactured from the raw materials.

Manufacturing accounts for a small share of the gross domestic product in Saskatchewan compared to most of the other provinces. Food and beverage processing is the most important type of manufacturing activity in Saskatchewan. Flour and cereal production and meat packing provide much of the income from food processing. The province's other food and beverage products include beer, bread, dairy products, livestock feed, and vegetable oil. Saskatoon has large flour mills and an oilseed crushing plant.

Other products manufactured in Saskatchewan include chemicals, electrical equipment, fabricated metal products, machinery, and printed materials. Chemicals for use in industry are the main kind produced in the province. Telecommunications equipment and computer parts are the leading electrical goods produced in the province. Farm machinery is the main type of machinery. Newspaper companies and print shops in Regina and Saskatoon turn out most of the printed materials.

Electric power and utilities. Plants that burn coal provide about 70 percent of Saskatchewan's electric power. About 25 percent comes from hydroelectric plants. Most of the remaining power is produced by plants that burn natural gas. The Saskatchewan Power Corporation, a government-owned company, controls most of the province's power plants. Other utility companies in the province provide gas and water service.

Transportation. An extensive network of paved two-lane highways links most of the major cities of southern Saskatchewan. Four-lane highways connect Regina to Saskatoon and Swift Current. The section between Regina and Swift Current is part of the Trans-Canada Highway. Most of the highways in northern Saskatchewan are unpaved.

The province's busiest airports are in Regina and Saskatoon. Several small airlines provide transportation to remote areas in the northern part of the province. Saskatchewan's major railway centers include Moose Jaw, Regina, Saskatoon, and Weyburn.

Communication. The first newspaper in the Saskatchewan region was the *Saskatchewan Herald,* established in Battleford in 1878. Today, Saskatchewan has three daily newspapers: *The Leader-Post* of Regina, *The Moose Jaw Times-Herald,* and the *Prince Albert Daily Herald.* About 90 weekly newspapers are published in Saskatchewan. About 5 newspapers are published once or twice a month.

Radio broadcasting in Saskatchewan began in 1922 when stations CHAB in Moose Jaw and CKCK in Regina went on the air. The province's first television stations, CKCK in Regina and CFQC in Saskatoon, began broadcasting in 1954. The province has about 30 radio stations and 10 major television stations. Television stations in smaller communities rebroadcast programming from the major stations. Cable television systems and Internet providers service many Saskatchewan communities.

Government

Lieutenant governor of Saskatchewan represents Queen Elizabeth II of the United Kingdom in her role as the queen of Canada. The lieutenant governor is appointed by the governor general in council of Canada. The position of lieutenant governor is largely honorary.

Premier of Saskatchewan is the actual head of the provincial government. Saskatchewan, like Canada itself, has a parliamentary form of government. The premier is an elected member of the Legislative Assembly. The person who serves as premier is usually the leader of

The premiers of Saskatchewan

	Party	Term
Walter Scott	Liberal	1905-1916
William M. Martin	Liberal	1916-1922
Charles A. Dunning	Liberal	1922-1926
James G. Gardiner	Liberal	1926-1929
James T. M. Anderson	Conservative	1929-1934
James G. Gardiner	Liberal	1934-1935
William J. Patterson	Liberal	1935-1944
Thomas C. Douglas	Co-operative Commonwealth Federation	1944-1961
Woodrow S. Lloyd	Co-operative Commonwealth Federation*	1961-1964
W. Ross Thatcher	Liberal	1964-1971
Allan E. Blakeney	New Democratic	1971-1982
Grant Devine	Progressive Conservative	1982-1991
Roy Romanow	New Democratic	1991-2001
Lorne Calvert	New Democratic	2001-

* Merged with labor unions in 1961 to form what is now called the New Democratic Party.

the majority party in the Legislative Assembly.

The premier presides over the Executive Council (cabinet). The Executive Council also includes other ministers who are chosen by the premier. These ministers usually are chosen from among the members of the premier's party in the Legislative Assembly. Each of these ministers directs one or more departments of the provincial government. The Executive Council, like the premier of Saskatchewan, resigns if it loses the support of a majority of the members of the Legislative Assembly. The Executive Council also resigns if the premier of Saskatchewan resigns or retires.

Legislative Assembly of Saskatchewan is a one-house legislature that makes the provincial laws. It has 58 members elected from the province's 58 electoral districts. Regina has 11 of the districts, Saskatoon has 11, and Moose Jaw and Prince Albert each have 2.

Members of the Legislative Assembly are elected to serve terms that may last up to five years. However, the lieutenant governor, acting on the advice of the premier, may call for an election before the end of the five-year period. If the lieutenant governor does call for an election, all members of the Legislative Assembly, including the premier, must run again for office.

Courts. Saskatchewan's highest court is the Court of Appeal. It consists of the chief justice of Saskatchewan and eight *puisne* (associate) judges. The Court of Queen's Bench has a chief justice and 39 other judges. This court holds sessions in various parts of Saskatchewan. All justices and judges are appointed by the governor general in council. The retirement age for the judges is 75. Some judges stay in office past the age of 75 and serve part-time as *supernumerary justices*. Provincial authorities appoint 45 judges of provincial courts.

Local government. There are no counties in Saskatchewan. It has 13 cities, 145 towns, 341 villages, and 197 rural municipalities. Most of these communities are governed by councils. Members of these councils are elected to serve terms that range from one to three years. A mayor or a *reeve* heads each council. These local governments operate in the southern, more populated half of the province. They govern in accordance with Saskatchewan's Municipalities Act.

There are 24 incorporated communities in Saskatchewan's Northern Administration District, which covers the thinly populated northern half of the province. Two of these communities are classified as Northern Towns, 13 as Northern Villages, and 9 as Northern Hamlets. These northern communities fall under the Northern Municipalities Act. Under this act, each of the communities has a local governing group.

Revenue. Taxes levied by the provincial government account for more than two-fifths of Saskatchewan's *general revenue* (income). Most of the general revenue comes from taxes on personal income and from sales taxes. The province also collects taxes from corporations and from purchasers of gasoline and tobacco products.

About a fourth of Saskatchewan's revenue comes from charges for the right to use its natural resources. The provincial government receives additional revenue from national and provincial tax-sharing arrangements.

Politics. The major political parties of Saskatchewan are (1) the Liberal Party, (2) the New Democratic Party, and (3) the Saskatchewan Party. The party that is now called the New Democratic Party was formed in 1961 by a merger of the Co-operative Commonwealth Federation (CCF) and several labor unions. The Saskatchewan Party was established in August 1997 by a number of Liberals and Progressive Conservatives. In November 1997, the province's Progressive Conservatives voted to make their party inactive. The Progressive Conservative Party was originally named the Conservative Party.

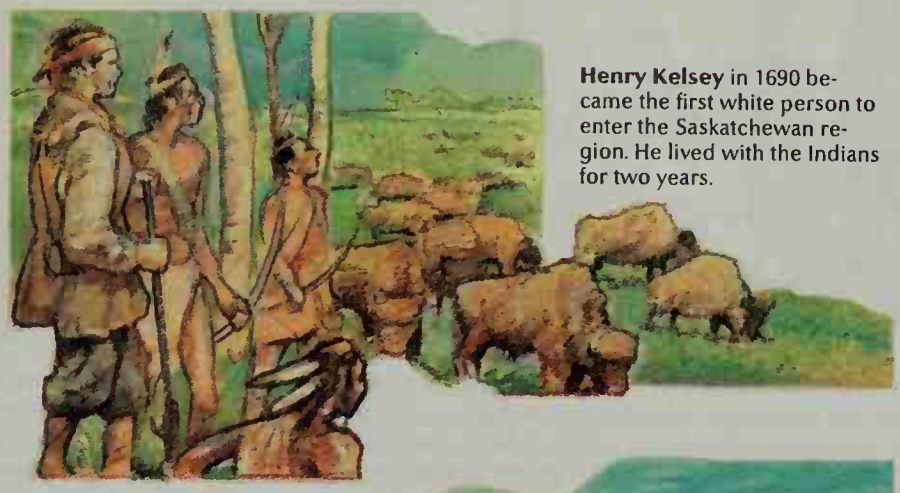
The Liberals controlled the provincial government from 1905, when Saskatchewan became a province, until 1929. A coalition government dominated by the Conservatives then took control of the provincial government. The Liberals regained power in 1934. The CCF, a socialist party, defeated the Liberals in 1944 and held office for 20 years. Since the mid-1960's, the government has been controlled by either the Liberal, New Democratic, or Progressive Conservative parties.

History

Early days. The first people to occupy the area that became Saskatchewan were Indians who probably arrived in the region about 12,000 years ago. Through the centuries, the Indians of the area developed a rich culture. Their daily lives were filled with spiritual meaning. They were skilled traders who exchanged goods and ideas with other groups. Perhaps most important, they were resourceful people who understood the natural world and readily adapted to changing conditions.

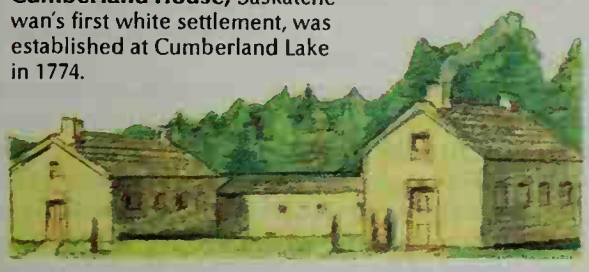
When Europeans arrived in Saskatchewan in the late 1600's and early 1700's, the Chipewyan lived in small bands in the northern woodlands. Their main food was caribou. In spring and fall, the bands joined in larger groups to hunt caribou as the animals migrated in large herds. The Chipewyan also hunted moose and smaller game, and they fished. The Cree were the most wide-

Historic Saskatchewan



Henry Kelsey in 1690 became the first white person to enter the Saskatchewan region. He lived with the Indians for two years.

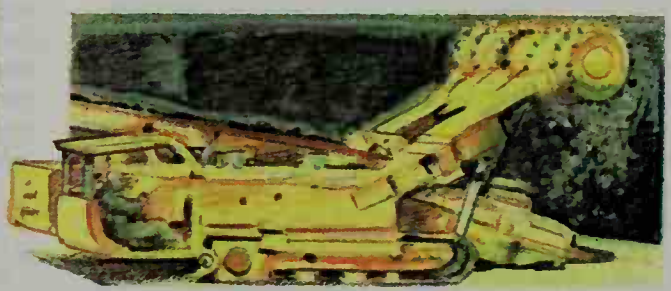
Cumberland House, Saskatchewan's first white settlement, was established at Cumberland Lake in 1774.



The Saskatchewan Wheat Pool, the world's largest grain-handling cooperative, was organized in Regina in 1924 to combat falling wheat prices.

Louis Riel led a métis rebellion against the Canadian government in 1885. The uprising was crushed that same year.

Huge potash beds were discovered in the early 1950's. Continuous production began in 1962.



WORLD BOOK illustrations by Kevin Chadwick

Important dates in Saskatchewan

1670 King Charles II of England granted trading rights in the region to the Hudson's Bay Company.

1690-1692 Henry Kelsey of the Hudson's Bay Company explored the Saskatchewan region.

1740's The La Vérendrye brothers, French-Canadian fur traders, built trading posts on the Saskatchewan River.

1774 Cumberland House, Saskatchewan's first permanent settlement, was established.

1870 Canada acquired Rupert's Land and made it part of the North West Territories.

1882-1883 The Canadian Pacific Railway (now CP Rail System) was built across the Saskatchewan region.

1885 The métis rebelled against the Canadian government in the North West Rebellion.

1905 Saskatchewan became a province on September 1.

1924 Farmers organized the Saskatchewan Wheat Pool.

1944 The voters of Saskatchewan elected the first socialist government in Canada.

1947 Saskatchewan became the first province to provide all residents with free hospital care financed by taxes.

1951-1952 Major deposits of petroleum were discovered in Saskatchewan.

1962 Continuous potash production started in Saskatchewan. The province began a program of tax-supported, free medical care for all residents.

1964 The Liberals defeated the socialist government.

1971 The New Democratic Party won power in the legislature and formed another socialist government.

1982 The Progressive Conservative Party came to power.

1991 The New Democratic Party returned to power.

Ernest Brown Collection, Province of Alberta

Cree Indians traded furs at Fort Pitt, a major trading post of the Hudson's Bay Company in western Saskatchewan. In 1885, the Cree looted and burned the fort.

spread group in central Saskatchewan. They took advantage of the resources of both forest and prairie. They lived on fish, waterfowl, and plants in the summer and turned to elk and deer during the winter. Those Cree living farthest to the north also hunted caribou, and those to the south hunted buffalo. In the south, the Assiniboine, Gros Ventre, and some Plains Cree hunted the large buffalo herds that roamed the plains.

The coming of the fur traders. The adaptability of the Indians enabled them to take advantage of the European fur trade when it arrived in western Canada. The Cree and Assiniboine, especially, profited by buying furs from the Indians who trapped them and selling the pelts to English and French traders.

In 1670, King Charles II of England granted control of a vast region of western Canada, including most of Saskatchewan, to the Hudson's Bay Company, an English fur-trading organization. The first European known to visit Saskatchewan was a Hudson's Bay Company employee named Henry Kelsey. From 1690 to 1692, Kelsey traveled in the west in an effort to contact new Indian groups and convince them to trade with the company.

In the mid-1700's, rival French fur traders expanded their operations into central Saskatchewan. In 1779, merchants and fur traders based in Montreal formed the North West Company to compete with the Hudson's Bay Company. The North West Company extended its operations across Saskatchewan during the late 1700's.

Growing competition led the North West and Hudson's Bay companies to build numerous trading posts and forts in Saskatchewan. In 1774, Samuel Hearne of the Hudson's Bay Company established a trading post at Cumberland Lake in Saskatchewan, the company's first inland post in Canada. The trading post, called Cumberland House, was the first continuously occupied settlement in Saskatchewan.

The two fur-trading companies decided to trade directly with the Indians who trapped the furs, no longer relying on the Cree and Assiniboine to buy pelts from the trappers. Those two tribes turned instead to supplying buffalo meat and other provisions for the fur traders. Using guns and horses acquired from the Europeans, some Cree moved onto the open plains to hunt buffalo.

In 1821, the two rival trading companies combined under the name Hudson's Bay Company and ended their intense competition. In Saskatchewan, the merged company closed many trading posts.

The coming of the missionaries. In the mid-1800's, Saskatchewan became the scene of much missionary activity. A Roman Catholic mission was established at Île-à-la-Crosse in 1846, and Roman Catholic influence soon spread through northwestern Saskatchewan. Anglican missionaries built the Church of the Holy Trinity at Stanley Mission near the west end of Lac La Ronge. The church, completed about 1860, stands as the oldest existing structure in Saskatchewan.

North West Territories. The Dominion of Canada, a union of four provinces, was created in 1867. In 1869, the Hudson's Bay Company agreed to sell the vast territory it controlled, including what are now northern Quebec, northern Ontario, and all the lands west to British Columbia, to the newly formed Dominion. The Dominion took control of the region in 1870. It created a small province of Manitoba and organized the remainder, including Saskatchewan, as the North West Territories.

In the late 1850's, the Irish explorer John Palliser, working for the British government, and the Canadian geologist Henry Y. Hind had led separate expeditions to central and southern Saskatchewan. Both reported that a broad belt of good land for farming ran through central Saskatchewan. As a result, the first European settlers in the 1870's headed to the valley of the North Saskatchewan River in central Saskatchewan. Battleford became the territorial capital in 1876.

In 1882 and 1883, the Canadian Pacific Railway built a transcontinental rail line across southern Saskatchewan, through Regina and Moose Jaw. In 1883, Regina officially became the new capital of the North West Territories.

Métis and Indian troubles. The building of the railroad disturbed the métis, people of mixed European and Indian ancestry. Many métis depended on the buffalo for much of their food. The railroad and the new settlement that it brought caused a rapid dwindling of the buffalo herds. The métis also feared they would lose their land to new settlers.

Because the federal government failed to respond to their petitions, the métis set up a temporary government at Batoche, Saskatchewan, in March 1885 to negotiate with Ottawa. Fighting broke out, and the federal government sent a large military force to Batoche to disband the métis. Government troops crushed the uprising, called the North West Rebellion, within three months.

The Indians of Saskatchewan also had troubles. After settlers nearly killed off the buffalo, the Indians were left without their chief source of food. The federal government urged them to become farmers instead of hunters,

but it gave them little help to make the transition.

Despite their troubles, few Indians became involved in the North West Rebellion. The Cree leaders Big Bear and Poundmaker tried to pursue peaceful dealings with Ottawa. Nevertheless, the Canadian government used the rebellion to justify harsh measures against the Cree. Many warriors were imprisoned for treason. Six Cree and two Assiniboine were executed at Battleford in November 1885 for their actions during the rebellion.

Territorial progress. Settlement was rapid in the late 1890's and early 1900's. Agricultural development gained strength after farmers began to plant a variety of wheat that thrived in Saskatchewan's short growing season. New settlers established homesteads in record numbers. From 1901 to 1911, the population increased from 91,279 to 492,432. Good free land and rising wheat prices attracted many immigrants from Scandinavia and central and eastern Europe. Rapid population growth spurred the building of railroads, towns, and cities.

Saskatchewan became a province of Canada in 1905. But the federal government kept control of Saskatchewan's public lands and natural resources, including its forests and mineral deposits, until 1930.

Saskatchewan farmers greatly increased the number of acres devoted to growing wheat during World War I (1914-1918). In 1915 alone, Saskatchewan harvested over 200 million bushels of wheat. In 1924, a group of farmers formed the Saskatchewan Wheat Pool to get higher prices for their grain by selling directly to international markets. Today, the Wheat Pool is one of the largest grain-marketing companies in the world. It collects, processes, sells, and ships the products of its members.

In response to international demand, the amount of land planted in wheat climbed further in the 1920's, topping 14 million acres (5.67 million hectares) in 1929. But the province's economy depended on a single crop, and prosperity rose and fell with world wheat prices. Saskatchewan farmers believed the federal government often failed to protect their interests. In 1920, farmers from Saskatchewan and other provinces formed the Progressive Party, hoping for a greater voice in national affairs.

The Great Depression of the 1930's hit Saskatchewan hard. Wheat prices plunged to a 300-year-low and sent shock waves through the economy. A prolonged drought and soil erosion, aggravated by poor tilling practices, compounded the crisis. Tens of thousands of farm families went on relief or abandoned their homesteads. Many people left the province. Single, homeless men wandered Canada by rail searching for work.

In 1935, hundreds of unemployed men organized the On to Ottawa Trek, an expedition from British Columbia to the nation's capital to appeal to the federal government for more help. The government ordered the demonstrators to halt at Regina. When police acting on federal orders tried to arrest the leaders in July 1935, a riot broke out. Many people were injured, and one police officer was killed.

Political changes resulted from the Depression. In 1944, Saskatchewan voters elected the Co-operative Commonwealth Federation (CCF), which formed the first socialist government in North America. Under its leader Thomas C. (Tommy) Douglas, the CCF swept to power determined to lessen the impact of poor harvests and dips in crop prices. The party backed the growth of manufacturing as well as natural resource development.

The CCF also pioneered in tax-supported health care. In 1962, the provincial government introduced a medical care plan for all citizens of the province. Saskatchewan doctors immediately withdrew their services, except in emergency cases. The doctors remained on strike for over three weeks until they reached a settlement with the province. The Saskatchewan program became the model for Canada's national medical care plan, commonly called *medicare*, adopted in 1966.

In 1961, the CCF merged with several labor unions to form a national party called the New Democratic Party. The Saskatchewan branch kept the CCF name until 1967, when it also became the New Democratic Party. The party controlled the provincial government from 1944 to 1964, when it lost to the Liberal Party.

Economic changes. During the middle and late 1900's, large farms replaced many of Saskatchewan's small family farms, and the number of farms decreased steadily. In the 1940's, about three-fourths of Saskatchewan's population lived in rural areas. By the early 1970's, only half the population was rural.

Other resources offered promise. Huge potash beds and major deposits of petroleum had been discovered in the 1940's and early 1950's. In 1971, the NDP regained control of the provincial government. It established the Potash Corporation of Saskatchewan in 1975 and bought several large potash mines for it to run.

From 1982 to 1991, the Progressive Conservative Party controlled Saskatchewan's government. The Progressive Conservatives rejected the NDP policy of government ownership. Instead, the Conservatives sought to generate wealth by aiding private enterprise. Neither party, however, managed to solve the basic problems of Saskatchewan's economy, which remained largely dependent on agriculture. The province's population declined in the late 1980's and early 1990's as people left in search of better economic opportunities.

In the 1980's and 1990's, the provincial economy benefited from the mining of rich uranium deposits in northern Saskatchewan and from large sales of potash. Another bright spot was a booming high technology industry in Saskatoon, especially the field of agricultural biotechnology. In 1991, the New Democratic Party regained control of the provincial government. Following elections in 1999, the NDP remained in power but with a reduced number of seats in the provincial legislature. Declining farm incomes reportedly cost the NDP votes in rural areas.

Many challenges lie ahead for Saskatchewan in the 2000's. The province needs to diversify its economy and develop a stable mix of economic activities. It needs to stem the outward flow of population, particularly its young people. Finally, it must end the isolation and poverty of its Indians and other native peoples, who make up a rapidly growing portion of the province's population. Adrian A. Seaborne and Bill Waiser

Study aids

Related articles in *World Book* include:

Cities

Moose Jaw Regina Saskatoon

History

Canada, History of
Hudson's Bay Company
Métis
North West Company
North West Rebellion
Riel, Louis

Physical features

Churchill River
Lake Athabasca
Reindeer Lake
Saskatchewan River

Other related articles

Canadian Shield
Hnatyshyn, Ramon J.
McNaughton, Andrew G. L.
Sauvé, Jeanne Mathilde

Outline

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A. Population
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H. Communication

V. Government
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B. Premier
C. Legislative Assembly
D. Courts
E. Local government
F. Revenue
G. Politics

VI. History

Questions

What is the chief farm product of Saskatchewan?
How did Saskatchewan pioneer in public health plans?
In which two cities do about a third of the people of Saskatchewan live?
What kinds of programs did the Co-operative Commonwealth Federation establish?
Where is Saskatchewan's chief farming region?
What is the Saskatchewan Wheat Pool?
Why did the métis of Saskatchewan rebel in 1885?
What is Saskatchewan's major manufacturing activity?
Which part of the province has the most rivers and lakes?
How does local government in southern and northern Saskatchewan differ?

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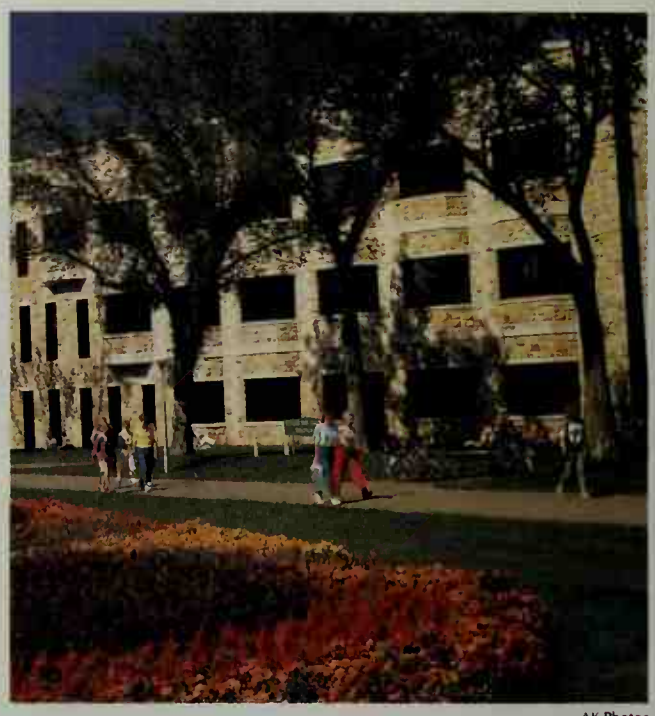


AK Photos

The University of Saskatchewan is in Saskatoon, along the east bank of the South Saskatchewan River. The university is the city's largest employer.

Saskatchewan, University of, is a coeducational university in Saskatoon, Canada. It is supported largely by the province of Saskatchewan. The university has colleges of agriculture, arts and science, commerce, dentistry, education, engineering, graduate studies, law, medicine, nursing, pharmacy, physical education, and veterinary medicine. There are departments of art, drama, and music, schools of agriculture and physical therapy, and an extension division. Courses at the University of Saskatchewan lead to bachelor's, master's, and doctor's degrees.

The University of Saskatchewan is associated with St. Thomas More College, which is a liberal arts school, and four theological schools—the Central Pentecostal College, the College of Emmanuel and St. Chad, Lutheran Theological Seminary, and St. Andrews College. The university was founded in 1907.

Critically reviewed by the University of Saskatchewan

Saskatchewan Rebellion. See North West Rebellion.

Saskatchewan River, *sas KACH uh WAHN,* begins in Alberta, Canada. Two branches join to make the stream. The river flows across Alberta and Saskatchewan and part of Manitoba. The North Saskatchewan rises west of Edmonton in glaciers in the Rocky Mountains. The South Saskatchewan is formed by the Bow and Oldman rivers near Grassy Lake. The branches flow east, and join near Prince Albert in Saskatchewan. The river then flows east into Manitoba, and empties into Cedar Lake, which —in turn—empties into Lake Winnipeg.

The branches of the South Saskatchewan River are used for irrigation in southern Alberta. Gardiner Dam, near Outlook, Saskatchewan, provides hydroelectric power. Lake Diefenbaker, formed by the dam, is an irrigation source and a recreational facility.

Adrian A. Seaborne

Saskatoon, *SAS kuh TOON* (pop. 196,811; met. area pop. 225,927), is the largest city in Saskatchewan and a major trading center of western Canada. The city lies on

Imagery Saskatoon

Saskatoon is the largest city in Saskatchewan. It lies on both sides of the South Saskatchewan River. Saskatoon serves as a trading center for western Canada's large farming region.

the South Saskatchewan River in the middle of the prairies of western Canada. For the location, see **Saskatchewan** (political map).

Settlers from Ontario founded Saskatoon in 1883. They chose the site because the river there made it an ideal spot for ferry and steamboat traffic. The settlers named the town for a berry that grows along the banks of the river.

Saskatoon covers 57 square miles (148 square kilometers) on both sides of the South Saskatchewan River. Seven bridges connect the two parts of the city. Saskatoon's metropolitan area covers 2,005 square miles (5,192 square kilometers).

The Western Development Museum in Saskatoon features one of the largest collections of antique cars, early farm equipment, and steam engines in North America. The Mendel Art Gallery/Civic Conservatory features Inuit sculpture and modern painting as well as displays of various plants. Saskatchewan Place, a large arena that was completed in 1988, hosts sporting events, concerts, and trade shows. Several sites related to the North West Rebellion of 1885 are near the city (see **North West Rebellion**).

Saskatoon is the home of the University of Saskatchewan. The university ranks as the largest employer in Saskatoon.

Saskatoon serves as the trading center of a farming region of about 70,000 square miles (180,000 square kilometers). The major highways of the region meet in Saskatoon, which is sometimes called the *Hub City*. Saskatoon's leading industries are food processing and such technological activities as the development of computer systems and electronic equipment. The area has some of the world's largest potash deposits, and uranium mines are north of the city.

Cree Indians lived in what is now the Saskatoon area before white people first arrived there in 1883. That year, 35 members of the Temperance Colonization Company settled in the area. The settlers, led by John Lake, came from Ontario. They founded Saskatoon, but they failed to achieve their goal of banning alcoholic beverages from the community. The Canadian Pacific Railway reached Saskatoon in 1890. The city's population reached about 5,000 in 1906, when Saskatoon was incorporated as a city.

During the 1930's, dust storms and the resulting crop failures caused great hardship in Saskatoon. Mining of the potash deposits near the city began in the early 1950's. During the 1960's, Saskatoon became an important supply center for Saskatchewan's mining industry, and new factories provided hundreds of jobs for the city's workers.

In the mid-1970's, the Canadian government built an oilseed and grain product development center on the University of Saskatchewan campus. The plant went into operation in 1977. Saskatoon has a mayor-council form of government. Wilfred Popoff

For the monthly weather in Saskatoon, see Saskatchewan (Climate).

Sasquatch. See **Bigfoot**.

Sassafras, *SAS uh fras,* is a medium-sized tree of the laurel family. It is found chiefly in the eastern United States. It also grows as a shrub along roads. The tree grows best in open woods in moist, well-drained soils. It may reach a height of 100 feet (30 meters).

William H. Allen, Jr.

The sassafras tree has slender branches.

The sassafras tree bears small, pale-yellow flowers. The leaves have one, two, or three lobes. The two-lobed leaves are shaped like a mitten. The green twigs, leaves, and bark have a spicy taste and fragrance. Sassafras tea is prepared by boiling the root bark. Oil of sassafras is distilled from the roots and bark and used to perfume soap. The soft, yellow wood of the tree is used for paneling, furniture, and fence posts. See also Tree (Familiar broadleaf and needleleaf trees [picture]).

Richard C. Schlesinger

Scientific classification. The sassafras tree belongs to the laurel family, Lauraceae. The scientific name for the sassafras tree is *Sassafras albidum*.

Sassanid dynasty. See Persia, Ancient (History).

Satan. See Devil.

Satellite is a natural object that orbits a planet or asteroid. Satellites are also called moons. All the planets except Mercury and Venus have satellites. The four *giant planets,* Jupiter, Saturn, Uranus, and Neptune, have many moons. At least two asteroids, called Eugenia and Ida, have single satellites.

Satellites vary greatly in size. The smallest one known, Ida's moon Dactyl, is about 1 mile (1.6 kilometers) across. The largest, Jupiter's Ganymede, has a diameter of 3,270 miles (5,262 kilometers). Of the more than 100 known satellites, only 28 have diameters greater than 100 miles (160 kilometers). A few satellites are larger than Pluto, the smallest planet. Ganymede and Saturn's moon Titan are also bigger than Mercury.

A satellite's composition depends on its distance from the sun and its geologic history. The satellites closest to the sun consist of a broad class of rock called *silicate.* This is the same material that makes up most of Earth's crust. The remaining moons are made up of silicate and ice. In general, the farther a satellite is from the sun, the higher is its percentage of ice. The majority of satellites consist mostly of ice. Most of the ice on satellites is water ice—like ordinary ice on Earth.

Many satellites appear rough, with craters dating from more than 3 billion years ago. Some satellites have changed geologically since then. These moons have a variety of surface features, including active volcanoes.

Some satellites have an atmosphere. Titan, which orbits Saturn, and Neptune's moon Triton have atmospheres that are dense enough to measure accurately. On the surface of Titan, the *atmospheric pressure* (pressure exerted by the weight of atmospheric gases) is 1.6 times greater than that of Earth. Triton's atmospheric pressure is only about $\frac{1}{70,000}$ that of Earth.

Scientists use telescopes and spacecraft to study satellites and their parent planets. Spacecraft have flown close to all the planets except Pluto. Human beings have set foot on only one satellite—Earth's moon.

Jet Propulsion Laboratory

Miranda, a satellite of Uranus, has three regions called *ovoids* whose outer ridges resemble race tracks. Internal geologic activity created the ovoids, probably in the past 2 billion years.

Formation of satellites

Many scientists believe that satellites formed at about the same time, and in the same way, as planets did. According to this theory, almost 5 billion years ago, a huge, disk-shaped cloud of gas and dust particles spun slowly in space. Particles collided, forming small chunks of material. The chunks, in turn, collided and formed larger objects. As an object grew in size, its gravity also increased. Once a body reached about 6 miles (10 kilometers) in diameter, it had enough gravity to pull other materials toward itself. Due to the object's increasing gravity, the build-up became extremely rapid. The object quickly pulled all nearby materials into itself.

An object in the center of the cloud pulled in most of the material. This object became the sun. Objects in the outer regions of the rotating disk cloud became planets and satellites.

The bombardment that built up the planets and satellites also heated them. As more materials gathered on the surface of an object, heat was trapped inside. In addition, unstable atoms called *radioactive isotopes* decayed within the body, increasing its heat. Gradually, the extreme heat inside the object melted its interior.

The densest materials then sank into the center of the body, becoming its core. Lighter materials rose to the surface. Gases, the lightest of all, escaped from the interior. Escaping gases formed atmospheres around all the planets, the two satellites that still have atmospheres, and, initially, probably other large satellites as well.

The bombardment also created craters of all sizes on the satellites and left extremely rough areas on their surfaces. On some satellites, melted material from the interior broke through the surface as volcanic eruptions. These eruptions covered some cratered areas and left them smooth.

Changes in chemical composition and temperature within new satellites expanded or contracted them. These expansions and contractions caused violent ruptures of the crust, creating mountains and steep valleys. Where internal forces pulled the surface apart, the ground broke in long, straight, parallel *faults* (cracks). Slivers of land moved down between the faults, creating a stairlike formation. This process, called *extensional tectonics,* was—and still is—the most common form of ground breakage on satellites.

By about 4.4 billion years ago, the planets and satellites were about as large as they are now. Meteorites continued to bombard them heavily until about 4 billion years ago.

The large satellites of the giant planets—except Neptune's Triton—probably came into existence in orbit around their parent planets. Triton, the smaller satellites of the giant planets, and the moons of Earth, Mars, and Pluto may have formed elsewhere. Some may have formed as independent objects with their own orbits around the sun. The planets' gravity would then have captured them. Others may have formed from pieces of the parent planet. If a huge object collided with the planet, the impact would have sent many fragments into orbit around the planet. Eventually, the fragments would have united, forming a satellite.

Types of satellites

Scientists study a satellite's surface features to learn about its geologic history. For example, the difference

in the number of craters in two different areas indicates the relative age of the two areas. The surface with more craters is older.

Many scientists divide satellites into four main groups based on their geologic history. The groupings are (1) currently active geologically, (2) recently active geologically—that is, active during the last 2 billion years, or about half the age of the solar system, (3) inert or inactive, and (4) geologic history unknown.

Currently active satellites include Io and Europa, which are satellites of Jupiter; Enceladus, a moon of Saturn; and Triton, a moon of Neptune.

Io, Jupiter's closest large satellite, is the most active moon in the solar system. Volcanoes send clouds of volcanic dust up to 190 miles (300 kilometers) above the surface. Constant eruptions create so much new terrain that Io's surface features consist of lava flows, mountains, and pits rather than craters.

The cause of Io's volcanic activity is the gravity of Jupiter and its other satellites. The different gravitational forces pull Io's interior in different directions. As a result, the interior *flexes* (bends) tremendously, creating immense heat. This process is known as *tidal heating*.

Io consists of silicate rock surrounding a large iron core. The satellite appears bright yellow because volcanic eruptions deposit sulfur and compounds of sulfur on its surface.

Europa, which orbits Jupiter next to Io, has a flat surface with many cracks and few craters. Europa consists of silicate rock covered with a shell of water ice. The ice is 20 to 30 miles (30 to 50 kilometers) thick and resembles Earth's polar ice packs.

Europa's ice may cover an ocean that has been kept liquid by tidal heating. If scientists were to confirm that Europa has a liquid ocean, they would want to study the ocean as a possible past or present home of life.

Enceladus, one of Saturn's satellites, has a varied surface. Small craters cover some regions, and plains with ridges extend over other areas. The plains formed when material containing water erupted across the satellite's surface and then froze.

Enceladus is only 307 miles (494 kilometers) in diameter. Because it is small and far from the sun, scientists expected to find that it had cooled and become geologically inactive soon after it formed. The satellite's continued activity may result from tidal heating and the chemistry of its interior. For example, the ice may contain a significant amount of ammonia, which greatly lowers the melting point of water ice. Ordinary water ice on Enceladus's cold surface would be as hard and strong as rock.

Triton, a satellite of Neptune, is the coldest body in the solar system. Its surface temperature is about −390 °F (−235 °C). This moon is half rock, half ice. Its core is silicate rock. Its surface consists of ices made of water, nitrogen, methane, carbon dioxide, and carbon monoxide.

Triton has few craters. Sheets of ice cover a surface broken by geysers of boiling nitrogen that erupt several miles or kilometers into the air. There is a thin nitrogen atmosphere. Strong winds carry small, dark particles away from the geysers, streaking Triton's icy surface.

Triton orbits in the opposite direction from most objects in the solar system. This moon may have achieved its odd orbit by forming as an independent object, then being captured by Neptune's gravity. During capture, the gravitational pull would have created enormous tides inside Triton. The entire satellite would have melted, triggering geologic activity that continues to this day.

Jet Propulsion Laboratory

Io, which orbits Jupiter, is the most active moon known. Volcanic eruptions, such as the one shown here, deposit sulfur and sulfur compounds, giving Io's surface its yellow color.

Recently active satellites include Ganymede, which orbits Jupiter, and several objects that are known as *middle-sized icy satellites*. These icy satellites orbit Saturn and Uranus.

Ganymede is the largest satellite in the solar system. Like Triton, Ganymede is half rock, half ice. It has a rocky core and a surface of dirty ice. It may have a thin ocean of water far beneath the surface.

About half the surface has been smoothed over by eruptions of relatively bright material. This material flowed into a global network of long valleys, creating bright lanes. The lanes separate regions that are older, darker, and more heavily cratered. Almost all the brighter material is wrinkled in a pattern of parallel ridges and hollows known as *grooved terrain*. Scientists believe that extensional tectonics created the network and wrinkles.

The middle-sized icy satellites have small, rocky cores covered with ice. Five of these moons, Saturn's Dione and Tethys and Uranus's Miranda, Ariel, and Titania, show geologic activity within the last 2 billion to 3 billion years. Their surfaces are covered with vast flows of ice broken by long, straight or curved furrows that probably resulted from extensional tectonics. Geologic activity may have begun with radioactive decay of interior material or with tidal heating. Both Miranda and Ariel have regions of grooved terrain like that of Ganymede.

Inert satellites have not changed since heavy bombardment by meteorites ended about 4 billion years ago. This group includes Earth's moon, Jupiter's Callisto, and most middle-sized and small satellites. Two of the middle-sized satellites, Saturn's Iapetus and Uranus's Oberon, have features that may indicate volcanic activity.

Satellites of the solar system*

Satellite of Earth

Name	Mean distance from planet In mi	In km	Diameter In mi	In km	Year of discovery
Moon	238,897	384,467	2,159	3,474	Known to ancients

Satellites of Mars

Name	Mean distance from planet In mi	In km	Diameter In mi	In km	Year of discovery
Phobos	5,827	9,378	13.9	22.4	1877
Deimos	14,577	23,459	7.6	12.2	1877

Satellites of Jupiter

Name	Mean distance from planet In mi	In km	Diameter In mi	In km	Year of discovery
Metis	79,600	128,100	25	40	1980
Adrastea	80,090	128,900	12	20	1979
Amalthea	112,700	181,400	91	146	1892
Thebe	137,900	221,900	62	100	1980
†Io	262,000	421,600	2,256	3,630	1610
†Europa	416,900	670,900	1,945	3,130	1610
‡Ganymede	664,900	1,070,000	3,272	5,268	1610
Callisto	1,170,000	1,883,000	2,986	4,806	1610
S/1975 J1 (S/2000 J11)	4,665,000	7,507,000	5	8	1975
Leda	6,941,000	11,170,000	6	10	1974
Himalia	7,121,000	11,460,000	106	170	1904
Lysithea	7,282,000	11,720,000	15	24	1938
Elara	7,295,000	11,740,000	50	80	1905
S/2000 J11	7,804,000	12,560,000	2.5	4.0	2000
S/2001 J10	11,792,000	18,978,000	1.2	2.0	2001
S/2000 J3	12,560,000	20,220,000	3.2	5.2	2000
S/2001 J8	12,870,000	20,712,000	1.2	2.0	2001
S/2001 J9	12,934,000	20,816,000	1.2	2.0	2001
S/2001 J2	12,950,000	20,841,000	2.5	4.0	2001
S/2000 J7	13,020,000	20,960,000	4.2	6.8	2000
S/2001 J7	13,047,000	20,997,000	1.9	3.0	2001
S/2000 J5	13,130,000	21,130,000	2.7	4.4	2000
Ananke	13,220,000	21,280,000	12	20	1951
S/2001 J3	13,250,000	21,324,000	2.5	4.0	2001
S/2001 J6	14,215,000	22,877,000	1.2	2.0	2001
S/2000 J6	14,340,000	23,080,000	2.4	3.8	2000
S/2000 J4	14,400,000	23,170,000	2.0	3.2	2000
S/2000 J9	14,480,000	23,310,000	3.1	5.0	2000
S/2001 J4	14,489,000	23,317,000	1.9	3.0	2001
S/2000 J10	14,530,000	23,390,000	2.4	3.8	2000
Carme	14,540,000	23,400,000	19	30	1938
S/2001 J11	14,541,000	23,401,000	1.9	3.0	2001
S/2001 J5	14,612,000	23,515,000	1.2	2.0	2001
Pasiphae	14,680,000	23,620,000	22	36	1908
S/2000 J2	14,760,000	23,750,000	3.2	5.2	2000
S/2001 J1	14,774,000	23,776,000	2.5	4.0	2001
S/2000 J8	14,860,000	23,910,000	3.4	5.4	2000
Sinope	14,880,000	23,940,000	17	28	1914
S/1999 J1	14,980,000	24,100,000	5	8	1999

Satellites of Saturn

Name	Mean distance from planet In mi	In km	Diameter In mi	In km	Year of discovery
Pan	83,005	133,583	12	20	1990
Atlas	85,540	137,670	21	34	1980
Prometheus	86,590	139,353	62	100	1980
Pandora	88,050	141,700	55	88	1980
Epimetheus	94,089	151,422	68	110	1980
Janus	94,120	151,472	118	190	1966
Mimas	115,280	185,520	244	392	1789
†Enceladus	147,900	238,020	307	494	1789
‡Tethys	183,090	294,660	656	1,056	1684
Telesto	183,090	294,660	16	25	1980
Calypso	183,090	294,660	10	16	1980
‡Dione	234,500	377,400	696	1,120	1684
Helene	234,500	377,400	20	32	1980
Rhea	327,490	527,040	949	1,528	1672
§Titan	759,210	1,221,830	3,200	5,150	1655
Hyperion	920,300	1,481,100	174	280	1848
Iapetus	2,212,900	3,561,300	892	1,436	1671
S/2000 S5	7,060,000	11,370,000	9	14	2000
S/2000 S6	7,110,000	11,440,000	6	10	2000
Phoebe	8,048,000	12,952,000	137	220	1898
S/2000 S2	9,445,000	15,200,000	12	20	2000
S/2000 S8	9,724,000	15,650,000	4	6	2000
S/2000 S11	10,180,000	16,390,000	16	26	2000
S/2000 S10	10,940,000	17,610,000	5	8	2000
S/2000 S3	11,280,000	18,160,000	20	32	2000
S/2000 S4	11,330,000	18,240,000	9	14	2000
S/2000 S9	11,630,000	18,710,000	4	6	2000
S/2000 S12	12,100,000	19,470,000	4	6	2000
S/2000 S7	12,720,000	20,470,000	4	6	2000
S/2000 S1	14,350,000	23,100,000	10	16	2000

Satellites of Uranus

Name	Mean distance from planet In mi	In km	Diameter In mi	In km	Year of discovery
Cordelia	30,930	49,770	25	40	1986
Ophelia	33,420	53,790	26	42	1986
Bianca	36,770	59,170	34	54	1986
Cressida	38,390	61,780	50	80	1986
Desdemona	38,950	62,680	40	64	1986
Juliet	39,990	64,350	58	94	1986
Portia	41,070	66,090	85	136	1986
Rosalind	43,460	69,940	45	72	1986
Belinda	46,760	75,260	50	80	1986
Puck	53,440	86,010	101	162	1985
‡Miranda	80,390	129,390	291	468	1948
‡Ariel	118,690	191,020	718	1,156	1851
Umbriel	165,470	266,300	726	1,169	1851
‡Titania	270,860	435,910	981	1,578	1787
Oberon	362,580	583,520	946	1,523	1787
Caliban	4,493,000	7,230,000	60	96	1997
Stephano	4,972,000	8,002,000	12	20	1999
Sycorax	7,568,000	12,179,000	118	190	1997
Prospero	10,202,000	16,418,000	19	30	1999
Setebos	10,849,000	17,459,000	19	30	1999

Satellites of Neptune

Name	Mean distance from planet In mi	In km	Diameter In mi	In km	Year of discovery
Naiad	29,967	48,227	36	58	1989
Thalassa	31,115	50,075	50	80	1989
Despina	32,638	52,526	92	148	1989
Galatea	38,496	61,953	98	158	1989
Larissa	45,701	73,548	120	193	1989
Proteus	73,102	117,647	258	416	1989
†Triton	220,440	354,760	1,680	2,700	1846
Nereid	3,425,900	5,513,400	211	340	1949

Satellite of Pluto

Name	Mean distance from planet In mi	In km	Diameter In mi	In km	Year of discovery
§Charon	12,200	19,600	737	1,186	1978

Some of these distances and diameters are approximations.
*Satellites are geologically inactive unless otherwise noted.
†Currently active geologically.
‡Recently active geologically.
§Geologic history unknown.

Earth's moon has many craters. Some areas, called *maria,* are lowlands of dark rock. Lava flow created the smooth surface of the maria. Other areas, called *highlands,* are rough and mountainous. See Moon.

Callisto resembles its neighbor Ganymede except for its surface. Callisto's surface is almost completely covered by craters. Scientists suspect that the two satellites differ because Ganymede was heated tidally but Callisto was not. Like Ganymede, Callisto may have an ocean of salty water beneath its surface.

Most of Callisto's craters measure from 6 to 21 miles (10 to 35 kilometers) across. The largest crater basin, known as Valhalla, is about 375 miles (600 kilometers) in diameter. More than 15 rings extend outward from the crater like circular waves created by throwing a stone into a pond. The largest ring has a diameter of about 1,900 miles (3,000 kilometers)—about two-thirds of the diameter of the satellite. A collision with a huge meteorite made the basin, and the rings formed as ripples after the impact.

Iapetus and Oberon are middle-sized icy satellites. Both are heavily cratered, and so scientists classify them as inert. However, both have regions covered with dark material that may indicate volcanic activity. On Oberon, the material appears to have squeezed from the interior onto the floors of a few impact craters. On Iapetus, dark material covers almost an entire hemisphere. If the dark material on Iapetus did not result from volcanic flow, it may have come from Phoebe, the next moon out from Iapetus. Phoebe may have lost material during meteorite collisions. The gravity of Iapetus would then have pulled in much of this material.

Geologic history unknown. Titan, which orbits Saturn, is the second largest satellite in the solar system. Its geologic history is unknown because scientific instruments can barely detect its surface through its thick atmosphere. The atmosphere consists mostly of nitrogen and has a brown haze that is chemically similar to the smog seen on Earth.

Pluto's satellite Charon has a diameter of 737 miles (1,186 kilometers), more than half that of the parent planet. Water ice covers Charon's surface. Scientists know little about Charon because no spacecraft has ever flown close to it and it is so far from Earth. Its closest approach to Earth is 2.7 billion miles (4.3 billion kilometers).

How scientists study satellites

Scientists use several techniques to gather information about satellites. The most useful means of studying satellites are telescopes and spacecraft.

Telescopes. Most telescopes used to study satellites are based on Earth's surface. The remainder are mounted in Earth-orbiting artificial satellites, such as the Hubble Space Telescope, and in spacecraft. Scientists use light gathered by telescopes in two ways. In *imaging,* they create pictures, which they then analyze. In *spectroscopy,* they analyze the light itself.

Imaging. Most telescopes are equipped with cameras that record images showing the relative brightness of a satellite's surface areas. A change in brightness in an area may indicate geologic activity, such as volcanic eruptions. Scientists photograph most satellites in black and white through a special light filter. To create a color picture, they combine several images taken with different colored filters.

Spectroscopy breaks up the sunlight reflected from a satellite into the light's individual colors. The colors form a rainbowlike band called a *spectrum.* Every chemical element absorbs and reflects certain wavelengths of light, producing an individual spectral pattern. By studying a satellite's spectral patterns, scientists can identify its chemical elements and determine whether the elements are solids, liquids, or gases. They can also measure its temperature. See **Light** (The nature of light).

To obtain spectral patterns, scientists use instruments called *spectrometers* that are attached to telescopes. They also use a device known as a *spectrograph,* which photographs the bands of colors. See **Spectrometer.**

Spacecraft missions provide much more accurate and complete information about satellites than do observations from Earth's surface or an Earth orbit. There are four types of missions: (1) *fly-by missions,* which pass near their target of study for a few hours; (2) *orbiter missions,* which usually travel in an *elliptical* (oval-shaped) orbit around a planet to study its satellites; (3) *surface landers,* which touch down on a satellite and provide a detailed analysis of the area near the landing site; and (4) *atmosphere probes,* which collect information about the atmosphere around the satellite.

Scientific instruments on fly-by and orbiter craft are smaller and lighter than Earth-based telescopes. But because the spacecraft fly near the satellites, the instruments can provide much more detailed images. In addition, they can gather spectral information about individual features of a satellite's surface.

Surface landers provide the most detailed information. They can analyze samples of a satellite's rocks, soil, and atmosphere. They also can use a technique called *sounding* to analyze the structure below the surface. An atmosphere probe drops into a satellite's atmosphere. Instruments on board the probe gather information.

History of satellite study. Galileo Galilei, an Italian scientist of the 1600's, created one of the earliest telescopes and was the first to observe the sky by telescope. In 1609, he made a telescope to study Earth's moon. The next year, he discovered Jupiter's four largest satellites—Io, Europa, Ganymede, and Callisto, which became known as the Galilean satellites. Over the next two centuries, scientists discovered Uranus and its four largest satellites and found satellites in orbit around Saturn.

During the 1850's, German scientists Robert W. Bunsen and Gustav Kirchhoff designed the first spectroscope. This instrument enabled scientists to identify the chemical composition of bodies in space. In 1944, American astronomer Gerard P. Kuiper became the first to discover an atmosphere surrounding a satellite. He used a spectrograph to find methane surrounding Titan.

By the mid-1900's, scientists had discovered 31 of the more than 100 satellites orbiting the planets. They had also learned the size, mass, density, and orbit dimensions of many satellites.

In 1959, the Soviet spacecraft Luna 2 crashed on Earth's moon, becoming the first artificial object to reach any satellite. The United States achieved a milestone in satellite exploration in 1969, when Apollo 11 astronauts set foot on the moon. See **Moon** (Apollo missions).

In 1979, two U.S. Voyager spacecraft flew by Jupiter. Voyager 2 transmitted to Earth the first detailed pictures

of the Galilean satellites. In 1980 and 1981, the two Voyagers flew by Saturn. They sent back data and photographs that led to or confirmed the discovery of nine satellites. In 1986, Voyager 2 took pictures that scientists used to discover 10 satellites around Uranus. Voyager 2 provided the first close-up views of satellites of Neptune in 1989.

In 1990, the Hubble Space Telescope took the first picture that shows the satellite Charon as a separate body from its parent planet, Pluto. Those two objects are so far from Earth that previous pictures had shown them blurred together.

The U.S. orbiter Galileo reached Jupiter in 1995. After dropping a small probe into Jupiter's atmosphere, Galileo entered the first of several orbits that would carry it to close encounters with the Galilean satellites.

Jeffrey M. Moore

See also Meteor; Planet; Solar system; Space exploration (Space probes; Apollo: mission to the moon).

Satellite, Artificial, is a manufactured object that continuously orbits the earth or some other body in space. Most artificial satellites orbit the earth. People use them to study the universe, help forecast the weather, transfer telephone calls over the oceans, assist in the navigation of ships and aircraft, monitor crops and other resources, and observe movements of military equipment on the ground.

Artificial satellites also have orbited the moon, the sun, Venus, and Mars. Such satellites mainly gather information about the bodies they orbit.

Strictly speaking, spacecraft that carry astronauts in orbit—space capsules, space shuttle orbiters, and space stations—are artificial satellites. So, too, are orbiting pieces of "space junk," such as burned-out rocket boosters and empty fuel tanks that have not fallen to the earth. This article does not deal with these kinds of satellites. For information on shuttles, space stations, and other spacecraft that carry astronauts, see **Space exploration.**

Artificial satellites differ from *natural satellites,* natural objects that orbit a planet. The earth's moon is a natural satellite. See **Satellite.**

The Soviet Union launched the first artificial satellite, Sputnik 1, in 1957. Since then, the United States and many other countries have developed, launched, and operated satellites. Today, more than 2,000 satellites are orbiting the earth.

Satellite orbits

Satellite orbits have a variety of shapes. Some are circular, while others are highly *elliptical* (egg-shaped). Orbits also vary in altitude. Some circular orbits, for example, are just above the atmosphere at an altitude of about 155 miles (250 kilometers), while others are more than 20,000 miles (32,200 kilometers) above the earth. The greater the altitude, the longer the *orbital period*—the time it takes a satellite to complete one orbit.

A satellite remains in orbit because of a balance between two factors: (1) the satellite's *velocity* (speed at which it would travel in a straight line), and (2) the gravitational force between the satellite and the earth. Were it not for the pull of gravity, a satellite's velocity would send it flying away from the earth in a straight line. But were it not for velocity, gravity would pull a satellite back to the earth.

To help understand the balance between gravity and velocity, consider what happens when a small weight is attached to a string and swung in a circle. If the string were to break, the weight would fly off in a straight line. However, the string acts like gravity, keeping the weight in its orbit. The weight and string can also show the relationship between a satellite's altitude and its orbital period. A long string is like a high altitude. The weight takes a relatively long time to complete one circle. A short string is like a low altitude. The weight has a rela-

NASA

An artificial satellite is designed to carry out a specific mission. One major type of satellite, called a communications satellite, performs the task of relaying information between different points in space and on the earth. The Tracking and Data Relay Satellite (TDRS), *shown in this picture,* carries out this mission, as evidenced by its many antennas. The umbrella-shaped and dishlike structures are antennas, as are the spike-shaped objects extending from the box in the middle of the satellite.

Important satellites

Date orbited	Name	Accomplishments
Scientific research satellites		
1957 Oct. 4	**Sputnik 1**	First artificial satellite.
1957 Nov. 3	**Sputnik 2**	First satellite with an animal (a dog) aboard.
1958 Jan. 31	**Explorer 1**	First U.S. satellite; discovered earth's radiation belts.
1958 Mar. 17	**Vanguard 1**	Discovered earth is slightly pear-shaped; first solar-powered satellite.
1959 Jan. 2	**Luna 1**	First satellite in orbit around the sun.
1959 Aug. 7	**Explorer 6**	Returned first images of earth taken from a satellite.
1960 Aug. 19	**Sputnik 5**	First satellite to return animals (two dogs) from orbit.
1962 Apr. 26	**Ariel 1**	First international satellite (American and British).
1968 Dec. 7	**OAO A2**	Carried telescopes to study distant stars.
1977 Aug. 12	**HEAO-1**	Used to survey and search for X-ray sources.
1979 Feb. 18	**Sage**	Used to study how atmospheric dust and aerosols affect sunlight.
1979 Oct. 30	**MAGSAT**	Mapped the magnetic field near the earth.
1980 Feb. 14	**SMM**	Observed the sun during a period of maximum solar activity.
1983 Jan. 25	**IRAS**	Performed all-sky survey for sources of infrared radiation in outer space.
1989 Nov. 18	**COBE**	Mapped remnants of energy released during the early moments of the universe.
1990 Apr. 5	**Pegsat**	First satellite launched from an airplane in flight.
1990 Apr. 25	**HST**	Very high-resolution optical telescope; largest in orbit.
1991 Apr. 7	**GRO**	Measures gamma rays originating in outer space and maps their sources.
1995 Dec. 2	**SOHO**	Orbiting solar observatory, used to study the sun.
Weather satellites		
1960 Apr. 1	**Tiros 1**	First successful weather satellite.
1964 Aug. 28	**Nimbus 1**	First satellite to monitor cloud cover and observe conditions over most of the earth's surface.
1970 Dec. 11	**NOAA-1**	Provided high-resolution images of weather conditions.

Date orbited	Name	Accomplishments
Communications satellites		
1958 Dec. 18	**Score**	First voice transmission from a satellite.
1960 Aug. 12	**Echo 1**	First communications satellite to relay messages by reflection.
1960 Oct. 4	**Courier 1B**	First communications satellite to relay messages electronically.
1962 July 10	**Telstar 1**	Relayed first TV pictures across the Atlantic Ocean.
1963 July 26	**Syncom 2**	First functional satellite in a gensynchronous orbit.
1965 Apr. 6	**Early Bird**	First commercial communicatinns satellite.
1983 Apr. 5	**TDRS**	Relays communications between other satellites and earth.
1983 Apr. 11	**RCA Satcom 6**	First fully transistorized nonmilitary satellite.
Navigation satellites		
1960 Apr. 13	**Transit 1B**	First navigation satellite.
1961 June 29	**Transit 4A**	First satellite with a nuclear power supply.
1978 Feb. 22	**Navstar 1**	First satellite in what would become the Global Positioning System.
Earth observation satellites		
1966 Feb. 3	**ESSA 1**	First operational environmental survey satellite.
1972 July 23	**ERTS-1 (Landsat 1)**	First satellite to map earth's resources continuously and comprehensively.
1976 May 4	**LAGEOS-1**	Measures movements in the earth's crust.
1983 Apr. 17	**Rohini 3**	Mapped resources for India.
1990 Jan. 22	**SPOT 2**	Maps earth's resources at high resolution.
1999 Dec. 18	**Terra**	Used to study how natural cycles and human activities affect Earth's climate.
Military satellites		
1959 Feb. 28	**Discoverer 1**	First satellite in a polar orbit.
1960 Aug. 10	**Discoverer 13**	First object recovered from orbit.
1976 Apr. 30	**NOSS-1**	Monitors locations of ships.
1987 June 20	**DMSP**	Provides weather data for U.S. military operations.
1994 Feb. 7	**Milstar**	Provides secure, jam-resistant worldwide communication for U.S. military use.

tively short orbital period.

Many types of orbits exist, but most artificial satellites travel in one of three types: (1) *high altitude, geosynchronous;* (2) *sun-synchronous, polar;* and (3) *low altitude.* Most orbits of these three types are circular.

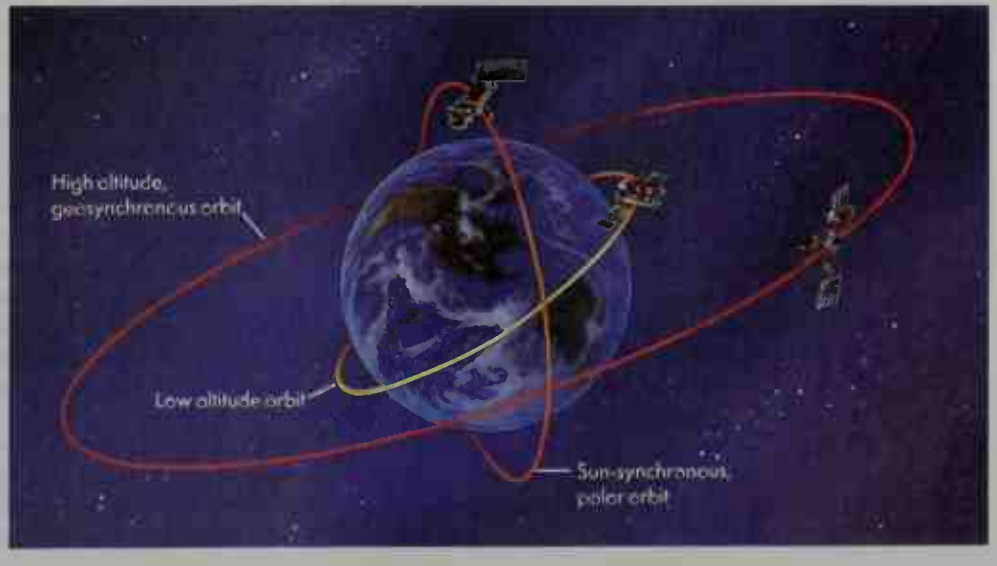
A high altitude, geosynchronous orbit lies above the equator at an altitude of about 22,300 miles (35,900 kilometers). A satellite in this orbit travels around the earth's axis in exactly the same time, and in the same direction, as the earth rotates about its axis. Thus, as seen from the earth, the satellite always appears at the same place in the sky overhead. To boost a satellite into a high altitude, geosynchronous orbit requires a large, powerful launch vehicle.

A sun-synchronous, polar orbit passes almost directly over the North and South poles. A slow drift of the orbit's position is coordinated with the earth's movement around the sun in such a way that the satellite always crosses the equator at the same local time on the earth. Because the satellite flies over all latitudes, its instruments can gather information on almost the entire surface of the earth. One example of this type of orbit is that of the NOAA-H satellite, which monitors the weather. The altitude of the orbit is 540 miles (870 kilometers), and the orbital period is 102 minutes. When the satellite crosses the equator, the local time is always either 1:40 a.m. or 1:40 p.m.

A low altitude orbit is within the earth's atmosphere, but the highest layer, where there is almost no air to cause drag on the spacecraft and reduce its speed. Because the orbit is so low, less energy is required to launch a satellite into it than would be needed to place the same satellite into either of the other two main types of orbit. Satellites that point toward deep space and

Satellite orbits

Most artificial satellites travel in one of the three types of orbits shown here. A *high altitude, geosynchronous orbit* is above the equator at an altitude of about 22,300 miles (35,900 kilometers). A *sun-synchronous, polar orbit* passes almost directly over the North and South poles several hundred miles above the earth. A *low altitude orbit* is in an almost airless level of the atmosphere that begins about 300 miles (480 kilometers) above the earth.



WORLD BOOK illustration by Ken Tiessen, Koralik Associates

Walter A. Bohan Co.

A weather satellite called the Geostationary Operational Environmental Satellite observes atmospheric conditions over a large area to help scientists study and forecast the weather.

U.S. Air Force

A military satellite in the United States Defense Meteorological Satellite Program provides weather information that could be used to advantage in wartime.

NASA

A scientific satellite, the Compton Gamma Ray Observatory, detected *gamma rays,* high-energy waves given off by such objects as supernovae and quasars, and by matter near black holes.

provide scientific information generally operate in this type of orbit. The Hubble Space Telescope, for example, operates at an altitude of about 380 miles (610 kilometers), with an orbital period of 97 minutes.

Types of artificial satellites

Artificial satellites are classified according to their mission. There are six main types of artificial satellites: (1) scientific research, (2) weather, (3) communications, (4) navigation, (5) earth observation, and (6) military.

Scientific research satellites gather data for scientific analysis. These satellites are usually designed to perform one of three kinds of missions. (1) Some gather information about the composition and effects of the space near the earth. They are placed in a variety of orbits. (2) Other satellites record changes in the earth and its atmosphere. Many of them travel in sun-synchronous, polar orbits. (3) Still others observe planets, stars, and other distant objects. Most of these satellites operate in low altitude orbits. Scientific research satellites also orbit other planets, the moon, and the sun.

Weather satellites help scientists study weather patterns and forecast the weather. Weather satellites observe the atmospheric conditions over large areas.

Some weather satellites travel in a sun-synchronous, polar orbit, from which they make close, detailed observations of weather over the entire earth. Their instruments measure cloud cover, temperature, air pressure, precipitation, and the chemical composition of the atmosphere. Because these satellites always observe the earth at the same local time of day, scientists can easily compare weather data collected under constant sunlight conditions. The network of weather satellites in these orbits also function as a search and rescue system. They are equipped to detect distress signals from all commercial, and many private, planes and ships.

Other weather satellites are placed in high altitude, geosynchronous orbits. From these orbits, they can always observe weather activity over nearly half the surface of the earth at the same time. These satellites photograph changing cloud formations. They also produce *infrared images,* which show the amount of heat coming from the earth and the clouds. Infrared pictures reveal weather patterns even at night.

Communications satellites serve as *relay stations,* receiving radio signal messages from one location and transmitting them to another. A communications satellite can relay several television programs or many thousands of telephone calls at once. Communications satellites are usually put in a high altitude, geosynchronous orbit over a *ground station.* A ground station has a large dish antenna for transmitting and receiving radio signals. Countries and commercial organizations such as television broadcasters and telephone companies use these satellites continuously.

Navigation satellites enable operators of aircraft, ships, and land vehicles anywhere on the earth to determine their locations with great accuracy. Hikers and other people on foot can also use the satellites for this purpose. The satellites send out radio signals that are picked up by a computerized receiver carried on a vehicle or held in the hand.

Navigation satellites operate in networks, and signals from a network can reach receivers anywhere on the earth. The receiver calculates its distance from at least three satellites whose signals it has received. It uses this information to determine its location.

Earth observation satellites are used to map and monitor our planet's resources. They follow sun-synchronous, polar orbits. Under constant illumination from the sun, they take pictures in different colors of visible light and in infrared radiation. Computers on the earth combine and analyze the pictures. Scientists use earth observation satellites to locate mineral deposits, to determine the location and size of freshwater supplies, to identify sources of pollution and study its effects, and to detect the spread of disease in crops and forests.

Military satellites include weather, communications, navigation, and earth observation satellites used for military purposes. Some military satellites—often called "spy satellites"—can detect the launch of missiles, the course of ships at sea, and the movement of military equipment on the ground.

The life and death of a satellite

Building a satellite. Every satellite carries special instruments that enable it to perform its mission. For example, a satellite that studies the universe has a telescope. A satellite that helps forecast the weather carries cameras to film the movement of clouds.

In addition to such mission-specific instruments, all satellites have basic *subsystems,* groups of devices that help the instruments work together and keep the satellite operating. For example, a *power subsystem* generates, stores, and distributes a satellite's electric power. This subsystem may include panels of solar cells that gather energy from the sun. *Command and data handling subsystems* consist of computers that gather and process data from the instruments and execute commands from the earth.

A satellite's instruments and subsystems are designed, built, and tested individually. Workers install them on the satellite one at a time until the satellite is complete. Then the satellite is tested under conditions like those that the satellite will encounter during launch and while in space. If the satellite passes all tests, it is ready to be launched.

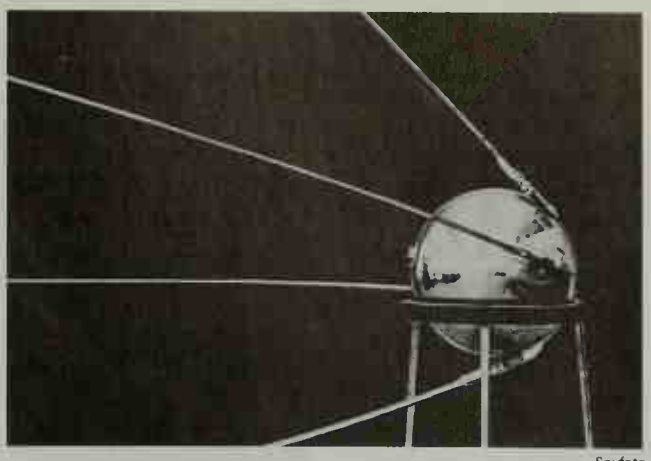
Launching the satellite. Space shuttles carry some satellites into space, but most satellites are launched by rockets that fall into the ocean after their fuel is spent. Many satellites require minor adjustments of their orbit before they begin to perform their function. Built-in rockets called *thrusters*—some as small as a mechanical pencil—make these adjustments. Once a satellite is placed into a stable orbit, it can remain there for a long time without further adjustment.

Performing the mission. Most satellites are under the direction of a *control center* located on the earth. Computers and human operators at the control center monitor the satellite's position, send instructions to its computers, and retrieve information that the satellite has gathered. The control center communicates with the satellite by radio. Ground stations send and receive the radio messages. These stations are located beneath the satellite's orbit or elsewhere within the satellite's range.

A satellite does not usually receive constant direction from its control center. It is like an orbiting robot. It controls its solar panels to keep them pointed toward the sun and keeps its antennas ready to receive commands. Its instruments automatically collect information.

Satellites in a high altitude, geosynchronous orbit are always in contact with the earth. Ground stations can contact satellites in low orbits as often as 12 times a day. During each contact, the satellite transmits information and receives instructions. Each contact must be completed during the time the satellite passes overhead—about 10 minutes.

If some part of a satellite breaks down, but the satellite remains capable of doing useful work, the satellite owner usually will continue to operate it. In some cases, ground controllers can repair or reprogram the satellite.



Sovfoto

Sputnik 1, the first artificial satellite, was launched by the Soviet Union in 1957. It transmitted radio signals that were received on earth.

In rare instances, space shuttle crews have retrieved and repaired satellites in space. If the satellite can no longer perform usefully and cannot be reprogrammed, operators from the control center will send a signal to shut it off.

Falling from orbit. A satellite remains in orbit until its velocity decreases and the gravitational force pulls it down into a relatively dense part of the atmosphere. A satellite slows down due to the friction of air particles in the upper atmosphere and the gentle pressure of the sun's energy. When the gravitational force pulls the satellite down far enough into the atmosphere, the satellite rapidly compresses the air in front of it. This air becomes so hot that most or all of the satellite burns up.

History

In 1955, the United States and the Soviet Union announced plans to launch artificial satellites. On Oct. 4, 1957, the Soviet Union launched Sputnik 1, the first artificial satellite. It circled the earth once every 96 minutes and transmitted radio signals that could be received on the earth. On Nov. 3, 1957, the Soviets launched a second satellite, Sputnik 2. It carried a dog named Laika, the first animal to soar in space. The United States launched its first satellite, Explorer 1, on Jan. 31, 1958, and its second, Vanguard 1, on March 17, 1958.

In August 1960, the United States launched the first communications satellite, Echo I. This satellite reflected radio signals back to the earth. In April 1960, the first weather satellite, Tiros I, sent pictures of clouds to the earth. The U.S. Navy developed the first navigation satellites. The Transit 1B navigation satellite first orbited in April 1960. By 1965, more than 100 satellites were being placed in orbit each year.

Since the 1970's, scientists have created new and more effective satellite instruments and have made use of computers and miniature electronic technology in satellite design and construction. In addition, more nations and some private businesses have begun to purchase and operate satellites. By the early 1990's, more than 20 countries owned satellites. About 2,000 satellites were operating in orbit.

John E. Oberright

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Remote sensing
Rocket (Launching probes and satellites)
Space exploration
Telecommunications
Weather satellite

Additional resources

Fox, Mary V. *Satellites.* Benchmark Bks., 1996. Younger readers.
Inglis, Andrew F., and Luther, A. C. *Satellite Technology.* 2nd ed. Focal Pr., 1997.

Sati. See Suttee.

Satie, *sah TEE,* **Erik,** *eh REEK* (1866-1925), a French composer, spent his entire career challenging established conventions in music. Satie was unconcerned about rules in music, and he especially disliked romanticism and impressionism.

Most of Satie's compositions are for the piano. Satie's most popular work is the first of his three *Gymnopédies* (1888). Many of his compositions contain humorous commentaries. They include *Sports and Entertainments* (1914) and *Bureaucratic Sonatina* (1917), which is a parody of a teaching piece by composer Muzio Clementi. Satie's eccentric sense of humor is reflected in his choice of titles, such as *Three Pieces in the Form of a Pear* (1903) and *Desiccated Embryos* (1913). His most famous large-scale compositions are the music for the ballet *Parade* (1917), which includes parts for a siren and typewriters, and the cantata *Socrate* (1919).

Eric Alfred Leslie Satie was born on May 17, 1866, in Honfleur, near Le Havre. He changed his first name to Erik in 1888. For many years, he barely earned a living as a cafe pianist in Paris. He began to gain recognition as a composer after about 1910. Stewart L. Ross

Satin, *SAT uhn,* is a weave in which the *weft* (crosswise yarns) do not cross the *warp* (lengthwise yarns) as often as in a plain weave. Satin also has no distinct diagonal pattern. Instead, the fabric is smooth and shiny. *Satin* also refers to silk, nylon, and rayon or cotton fabrics with a satin weave. Phyllis Tortora

Satire is the use of irony or sarcasm to attack some form of human behavior. Most satire appears in literature, but satire also plays a part in most other art forms. Most satirists claim they want to expose and reform such human failings as greed or vanity. But some satirists simply seem to enjoy ridiculing human conduct.

The art of satire was perfected by two ancient Roman writers, Horace and Juvenal. The gentle mockery of Horace and the bitter savagery of Juvenal have come to represent two of the main kinds of satire—*Horatian* (mild) and *Juvenalian* (bitter).

Satire appears in all national literatures. The comedies of Aristophanes satirize Greek society of the 400's B.C. François Rabelais's novel *Gargantua and Pantagruel* ridicules French political, religious, and social institutions of the 1500's. Nikolai Gogol poked fun at Russians of the 1800's in his novels and plays.

A great period of satire occurred during the late 1600's and early 1700's in English literature. Most of the important writers of this period wrote brilliant satiric works. For example, Alexander Pope's *The Dunciad* bitterly attacks the deterioration of culture, especially by bad literature and education. Perhaps the greatest work of satire in English is Jonathan Swift's *Gulliver's Travels.* It was adapted into a children's story, but Swift meant to satirize politics, science, and many other subjects.

The American cartoonists Al Capp, Jules Feiffer, Walt Kelly, and Garry Trudeau became famous for their satire. Leading satirists among artists include William Hogarth of England and Honoré Daumier of France. Preston Sturges of the United States directed many satirical movies.

In the mid-1900's, *black humor* largely replaced traditional satire. Black humor criticizes human behavior but offers no hope for reform. H. George Hahn

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Pope, Alexander
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Shaw, George Bernard
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Swift, Jonathan
Twain, Mark
Voltaire

Additional resources

Griffin, Dustin H. *Satire: A Critical Reintroduction.* Univ. Pr. of Ky., 1994.
Jones, Steven E. *Satire and Romanticism.* St. Martin's, 2000.

Satrap, *SAY trap* or *SAT rap,* was the governor of a *satrapy* (province) in the ancient Persian Empire. The satrap also served as the tax collector and chief judge of the province. Satraps continued to rule after Alexander the Great conquered the empire in 331 B.C. Richard Nelson Frye

Saturation, *SACH uh RAY shuhn,* is a term used in chemistry and physics. Chemists say that a solution is *saturated* when no more of a substance will dissolve in it at the same temperature and pressure. *Saturation* is also a term used to describe the electronic structure of certain molecules. Saturated molecules do not have double or triple bonds. In *saturated organic molecules,* a single bond connects each carbon atom to four other atoms (see **Bond** [chemical]). Mark S. Wrighton

See also **Evaporation.**

Saturday, called *Saeter-daeg* by the Anglo-Saxons, is the seventh day of the week. It is named for the Roman god Saturn and is the only day named for a Roman god. Saturday is the Sabbath among the Jews and the Seventh-day Adventists. Most employers give their workers either a half holiday or a full holiday on Saturday. See also **Week.** Jack Santino

Saturn was an early god in Roman mythology. The ancient Romans probably considered him a god of fertility and planting. The few myths about Saturn that remain depict him as presiding over a golden age of happiness and plenty in the distant past. The name *Saturn* is probably Etruscan in origin. The Romans later identified Saturn with the Greek god Cronus. Under the influence of the Greek myths, Saturn's wife was Ops, the goddess of the plentiful harvest.

Each year, the Romans honored Saturn with a festival called the *Saturnalia.* The festival began on December 17 and lasted seven days. During this period, schools and businesses closed, no criminals could be punished, and Roman armies could not start wars. Slaves and masters became equals for the time of the celebration. In addition, most rules of public conduct were suspended, and entire communities celebrated freely during the Saturnalia. Daniel P. Harmon

See also **Cronus; Saturnalia.**

NASA

Saturn is encircled by seven major rings. In this photograph, a section of the rings is hidden by the shadow of the planet. The small object below Saturn is Rhea, one of its moons. Another moon, Dione, appears at the right.

Saturn is the second largest planet. Only Jupiter is larger. Saturn has seven thin, flat rings around it. The rings consist of numerous narrow ringlets, which are made up of ice particles that travel around the planet. The gleaming rings make Saturn one of the most beautiful objects in the solar system. Jupiter, Neptune, and Uranus are the only other planets known to have rings. Their rings are much fainter than those around Saturn.

Saturn's diameter at its equator is about 74,900 miles (120,540 kilometers), almost 10 times that of the earth. The planet can be seen from the earth with the unaided eye, but its rings cannot. Saturn was the farthest planet from the earth that the ancient astronomers knew about. They named it for the Roman god of agriculture.

Orbit. Saturn is the sixth closest planet to the sun. Its mean distance from the sun is about 888,200,000 miles (1,429,400,000 kilometers), compared with about 93,000,000 miles (150,000,000 kilometers) for the earth. At its closest approach to the earth, Saturn is about 762,700,000 miles (1,277,400,000 kilometers) away.

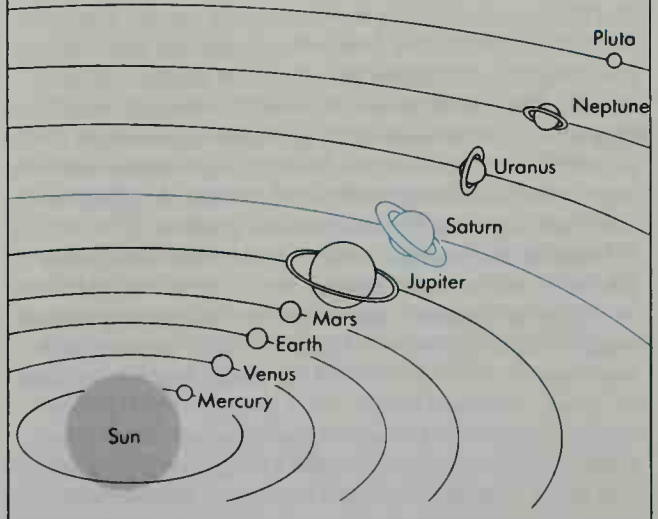
Saturn travels around the sun in an elliptical (oval-shaped) orbit. Its distance from the sun varies from about 937,600,000 miles (1,508,900 kilometers) at its farthest point to about 838,800,000 miles (1,349,900 kilometers) at its closest point. The planet takes about 10,759 Earth days, or about 29 $\frac{1}{2}$ Earth years, to go around the sun, compared with 365 days, or one year, for the earth.

Rotation. As Saturn travels around the sun, it spins on its axis, an imaginary line drawn through its center. Saturn's axis is not perpendicular (at an angle of 90°) to the planet's path around the sun. The axis tilts at an angle of about 27° from the perpendicular position. See Planet (illustration: The axes of the planets).

The contributor of this article is Hyron Spinrad, Professor of Astronomy at the University of California, Berkeley.

Saturn at a glance

Saturn, shown in blue in the diagram, is the sixth closest planet to the sun. Astronomers still use the ancient symbol for Saturn, *right*



Distance from the sun: *Shortest*—838,800,000 mi (1,349,900,000 km); *Greatest*—937,600,000 mi (1,508,900,000 km); *Mean*—888,200,000 mi (1,429,400,000 km).
Distance from the earth: *Shortest*—762,700,000 mi (1,277,400,000 km); *Greatest*—1,030,000,000 mi (1,658,000,000 km).
Diameter: 74,898 mi (120,536 km).
Length of year: About 29 $\frac{1}{2}$ Earth years.
Rotation period: 10 hours 39 minutes.
Temperature: −290 °F (−180 °C).
Atmosphere: Hydrogen, helium, methane, ammonia, ethane, and phosphine (?).
Number of satellites: 30.

Saturn rotates faster than any other planet except Jupiter. Saturn spins around once in only 10 hours 39 minutes, compared to about 24 hours, or one day, for the earth. The rapid rotation of Saturn causes the planet to bulge at its equator and flatten at its poles. The planet's diameter is 8,000 miles (13,000 kilometers) larger at the equator than between the poles.

Surface and atmosphere. Most scientists believe Saturn is a giant ball of gas that has no solid surface. However, the planet seems to have a hot solid inner core of iron and rocky material. Around this dense central part is an outer core that probably consists of ammonia, methane, and water. A layer of highly compressed, liquid metallic hydrogen surrounds the outer core. Above this layer lies a region composed of hydrogen and helium in a *viscous* (syruplike) form. The hydrogen and helium become gaseous near the planet's surface and merge with its atmosphere, which consists chiefly of the same two elements.

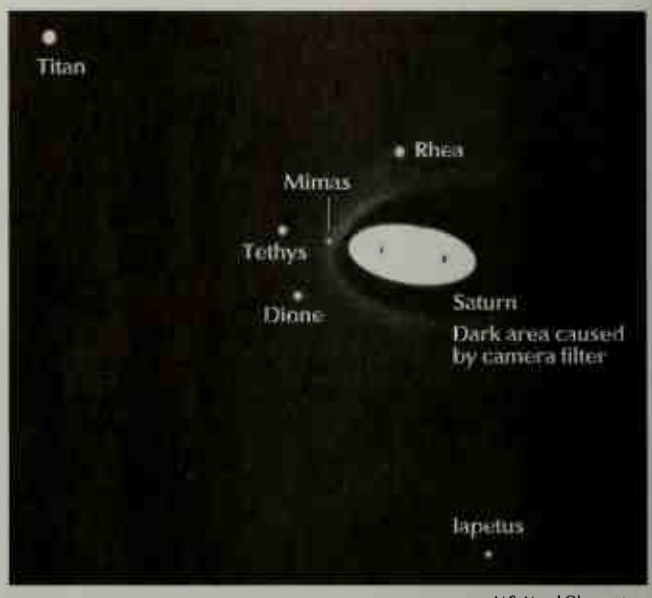
A dense layer of clouds covers Saturn. Photographs of the planet show a series of belts and zones of varied colors on the cloud tops. This banded appearance seems to be caused by differences in the temperature and altitude of atmospheric gas masses. The plants and animals that live on the earth could not live on Saturn. Scientists doubt that any form of life exists on the planet.

Temperature. The tilt of Saturn's axis causes the sun to heat the planet's northern and southern halves unequally, resulting in seasons and temperature changes. Each season lasts about 7 $\frac{1}{2}$ Earth years because Saturn takes about 29 times as long to go around the sun as Earth does. Saturn's temperature is always much colder than the earth's, because Saturn is so far from the sun. The temperature at the top of Saturn's clouds averages −285 °F (−175 °C).The temperatures below Saturn's clouds are much higher than those at the top of the clouds. The planet gives off about 2 $\frac{1}{2}$ times as much heat as it receives from the sun. Many astronomers believe that much of Saturn's internal heat comes from energy generated by the sinking of helium slowly through the liquid hydrogen in the planet's interior.

Density and mass. Saturn has a lower *density* than any other planet (see **Density**). It is only about one-tenth as dense as the earth, and about two-thirds as dense as water. That is, a portion of Saturn would weigh much less than an equal portion of the earth, and would float in water. Although Saturn has a low density, it has a greater *mass* than any other planet except Jupiter (see Mass). Saturn is about 95 times as massive as the earth. The force of gravity is a little higher on Saturn than on earth. A 100-pound object on earth would weigh about 107 pounds on Saturn.

Rings. The rings of Saturn surround the planet at its equator. They do not touch Saturn. As Saturn orbits the sun, the rings always tilt at the same angle as the equator. The seven rings of Saturn consist of thousands of narrow ringlets. The ringlets are made up of billions of pieces of ice. These pieces range from ice particles that are the size of dust to chunks of ice that measure more than 10 feet (3 meters) in diameter.

Saturn's major rings are very wide. The outermost ring may measure as much as 180,000 miles (300,000 kilometers) across. But the rings of Saturn are so thin that they cannot be seen when they are in direct line with the earth. They vary in thickness from about 660 to 9,800 feet (200 to 3,000 meters). A space separates the rings from one another. Each gap is about 2,000 miles (3,200 kilometers) or more in width. But some of the gaps between the major rings contain ringlets.

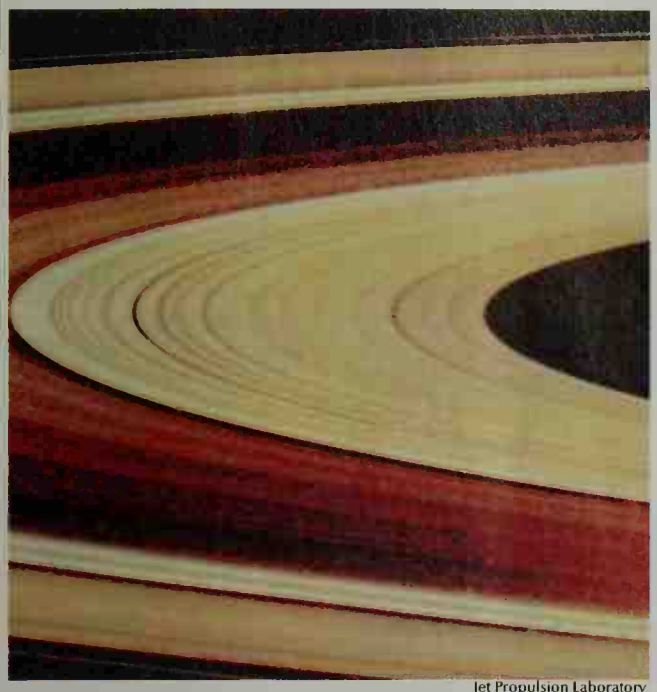


U.S. Naval Observatory

Saturn and six of its satellites can be seen in this telescopic photograph. The dark area around Saturn is caused by a camera filter used to reduce the bright light reflected by the planet. Titan, the largest of Saturn's satellites, is one of the few in the solar system known to have an atmosphere.

Satellites of Saturn

Name	Mean distance from Saturn In mi	In km	Diameter of satellite In mi	In km	Year of discovery
Pan	83,005	133,583	12	20	1990
Atlas	85,540	137,670	21	34	1980
Prometheus	86,590	139,353	62	100	1980
Pandora	88,050	141,700	55	88	1980
Epimetheus	94,089	151,422	68	110	1980
Janus	94,120	151,472	118	190	1966
Mimas	115,280	185,520	244	392	1789
Enceladus	147,900	238,020	307	494	1789
Tethys	183,090	294,660	656	1,056	1684
Telesto	183,090	294,660	16	25	1980
Calypso	183,090	294,660	10	16	1980
Dione	234,500	377,400	696	1,120	1684
Helene	234,500	377,400	20	32	1980
Rhea	327,490	527,040	949	1,528	1672
Titan	759,210	1,221,830	3,200	5,150	1655
Hyperion	920,300	1,481,100	174	280	1848
Iapetus	2,212,900	3,561,300	892	1,436	1671
S/2000 S5	7,060,000	11,370,000	9	14	2000
S/2000 S6	7,110,000	11,440,000	6	10	2000
Phoebe	8,048,000	12,952,000	137	220	1898
S/2000 S2	9,445,000	15,200,000	12	20	2000
S/2000 S8	9,724,000	15,650,000	4	6	2000
S/2000 S11	10,180,000	16,390,000	16	26	2000
S/2000 S10	10,940,000	17,610,000	5	8	2000
S/2000 S3	11,280,000	18,160,000	20	32	2000
S/2000 S4	11,330,000	18,240,000	9	14	2000
S/2000 S9	11,630,000	18,710,000	4	6	2000
S/2000 S12	12,100,000	19,470,000	4	6	2000
S/2000 S7	12,720,000	20,470,000	4	6	2000
S/2000 S1	14,350,000	23,100,000	10	16	2000



Jet Propulsion Laboratory

The dark side of Saturn's rings was photographed by Voyager 1 as it flew by the side opposite the sun. The dense B-ring—the reddish-brown band—appears dark because it blocks much of the sunlight. It is the brightest ring when viewed from the earth.

Saturn's rings were discovered in the early 1600's by the Italian astronomer Galileo. Galileo could not see the rings clearly with his small telescope and thought they were large satellites. In 1656, after using a more powerful telescope, Christiaan Huygens, a Dutch astronomer, described a "thin, flat" ring around Saturn. Huygens thought the ring was a solid sheet of some material. In 1675, Giovanni Domenico Cassini, an Italian-born French astronomer, announced the discovery of two separate rings made up of swarms of satellites. Later observations of Saturn resulted in the discovery of more rings. The ringlets were discovered in 1980.

Satellites. In addition to its rings, Saturn has 30 known satellites. The largest, Titan, has a diameter of about 3,200 miles (5,150 kilometers)—larger than the planets Mercury and Pluto. Titan is one of the few satellites in the solar system known to have an atmosphere. Its atmosphere consists largely of nitrogen.

Many of Saturn's satellites have large craters. Mimas has a crater that covers about one-third the diameter of the satellite. Another satellite, Iapetus, has a bright side and a dark side. The bright side of this satellite reflects about 10 times as much sunlight as the dark side. The satellite Hyperion is shaped somewhat like a squat cylinder rather than like a sphere. Unlike Saturn's other satellites, Hyperion's axis does not point toward the planet.

Flights to Saturn. In 1973, the United States launched a probe to study both Saturn and Jupiter. This craft, called Pioneer-Saturn, sped by Jupiter in 1974 and flew within 13,000 miles (20,900 kilometers) of Saturn on Sept. 1, 1979. The probe sent back scientific data and close-up photographs of Saturn. The data and photographs led to the discovery of two of the planet's outer rings.

Pioneer-Saturn also found that the planet has a magnetic field, which is 1,000 times as strong as that of the earth. This field produces a large *magnetosphere* (zone of strong magnetic forces) around Saturn. Data from the probe also indicated the presence of radiation belts inside the planet's magnetosphere. The belts consist of high-energy electrons and protons, and are comparable to the earth's *Van Allen belts* (see Van Allen belts).

In 1977, the United States launched two space probes—Voyager 1 and Voyager 2—to study Saturn and other planets. Voyager 1 flew within 78,000 miles (126,000 kilometers) of Saturn on Nov. 12, 1980. On Aug. 25, 1981, Voyager 2 flew within 63,000 miles (101,000 kilometers) of the planet. The Voyager probes confirmed the existence of Saturn's seventh ring. They also found that the planet's rings are made up of ringlets and sent back data and photographs that led to the discovery or confirmation of the existence of nine satellites. The Voyager probes also determined that the atmosphere of Titan consists chiefly of nitrogen. In 1997, the United States launched the Cassini probe to study Saturn, its rings, and its satellites. The probe was scheduled to reach Saturn in 2004. Cassini also carried a probe called Huygens, which was to separate from Cassini and land on Titan. Huygens was built by the European Space Agency, an organization of European nations. Hyron Spinrad

Related articles in *World Book* include:

Cassini	Planet	Solar system
Cassini, Giovanni Domenico	Satellite (Types of satellites)	Titan
		Voyager

Additional resources

Kerrod, Robin. *Saturn.* Lerner, 2000. Younger readers.
Landau, Elaine. *Saturn.* Watts, 1991. Younger readers.

Saturnalia, *SAT uhr NAY lee uh,* was an ancient Roman festival that honored Saturn, the god of agriculture. The Saturnalia began on December 17. It lasted two days at first but was eventually extended to a week.

The Saturnalia may have originated as a thanksgiving celebration to commemorate the winter planting. However, it later lost its agricultural significance and became a time of general merriment. Even slaves were given temporary freedom to do as they pleased. The Saturnalia featured feasting, visiting, and gift giving. The most popular gifts were wax candles and small clay figurines.

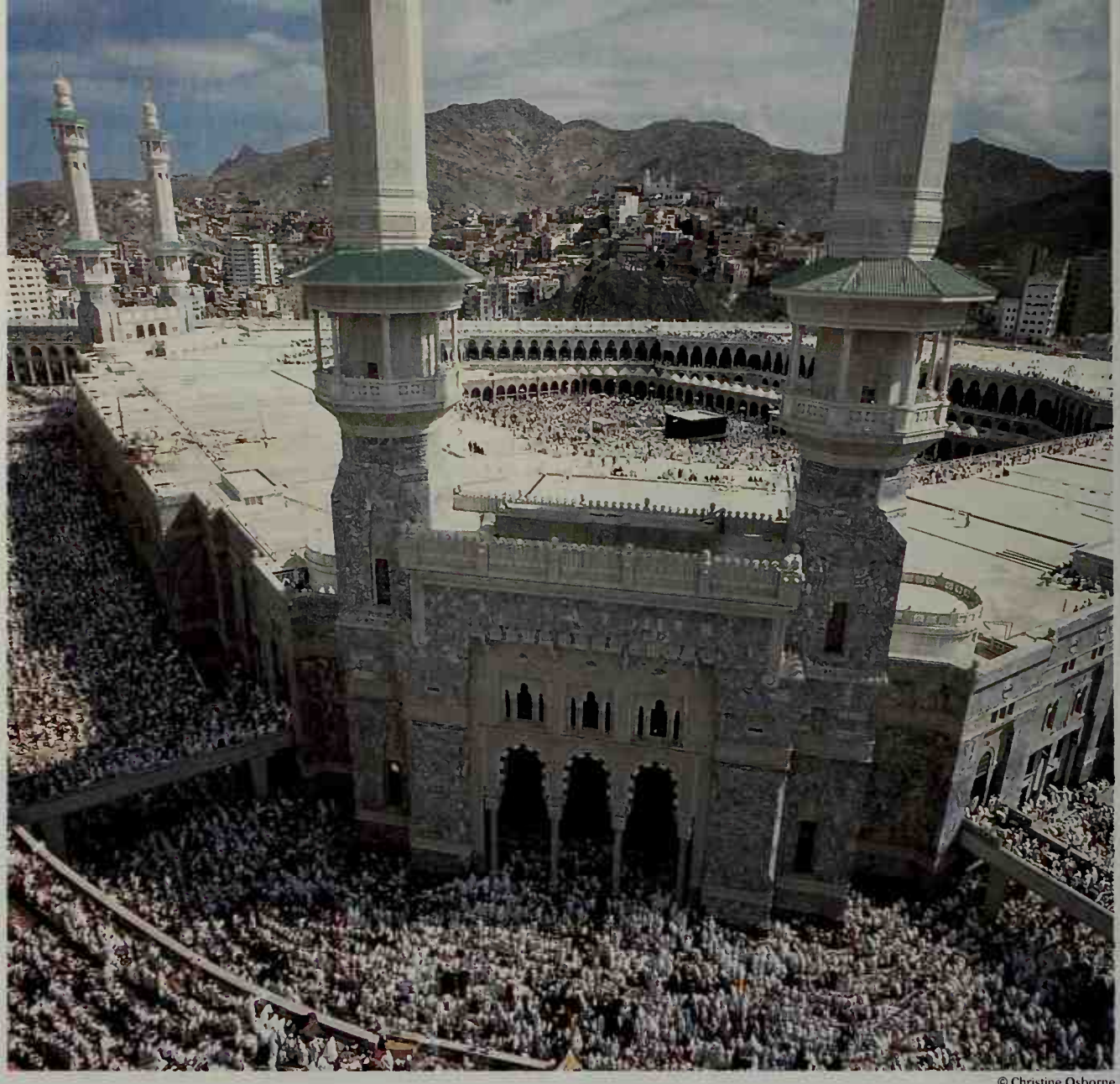
The festival resembled celebrations in other parts of the ancient world that took place during December. Some features of Saturnalia may have influenced the way that people celebrate Christmas today.

Daniel P. Harmon

See also Saturn (Roman god).

Satyr, *SAT uhr* or *SAY tuhr,* was a minor god of the countryside and woods in Greek mythology. Satyrs looked basically like ordinary human beings. But most of them had some animal features, such as goats' legs, hoofs, horns, and pointed ears, in a number of different combinations. Satyrs followed Dionysus, the god of wine, and Pan, the god of woods and pastures. Most satyrs were young, playful, and mischievous. They sometimes became wild and uncontrolled but rarely harmed anyone. Their favorite occupations were drinking wine and pursuing lovely maidens called *nymphs.* They also enjoyed music and dancing. Some older satyrs, though drunkards, were considered extremely wise. The Roman word for a satyr was *faun.* See also Dionysus; Faun; Pan. John Hamilton

Saucer, Flying. See Unidentified flying object.



© Christine Osborne

The Great Mosque in Mecca, Saudi Arabia, attracts millions of Muslim pilgrims every year. Mecca is one of the holiest cities of Islam. It is the birthplace of the Prophet Muhammad, whose life and teachings form the basis of Islam. All people who hold Saudi citizenship are Muslims.

Saudi Arabia

Saudi Arabia, *SAW dee, sah OO dee,* or *SOW dee,* is a large Middle Eastern nation that ranks as the world's leading producer of petroleum. Much of the country consists of vast deserts where few people live and little or nothing grows. But beneath the sand and rock and the offshore waters of Saudi Arabia lie the largest known petroleum deposits in the world.

Saudi Arabia exports more oil than any other nation. Wealth from these exports has made Saudi Arabia a leading economic power in the Middle East. Automobiles and trucks speed along highways where camel caravans once provided the only transportation. High-rise office buildings and large homes of concrete, steel, and marble have replaced nearly all the mud houses that once lined city streets.

Saudi Arabia includes about three-fourths of the land region called the Arabian Peninsula. The country is bordered by Jordan, Iraq, and Kuwait to the north; the Persian Gulf (which Saudis call the Arabian Gulf) and the United Arab Emirates to the east; Oman and Yemen to the south; and the Red Sea to the west. Riyadh is Saudi Arabia's capital and largest city.

The landscape of Saudi Arabia is mainly barren. Coastal plains and rugged mountains cover the western part of the country. Most of Saudi Arabia's central area is a high plateau that has some oases where crops are grown. Deserts hem in the plateau to the north, south, and east. Within the eastern desert and along the Gulf coast lie most of Saudi Arabia's rich oil fields.

Before the development of Saudi Arabia's oil industry in the mid-1900's, most of the people lived in rural areas and made a living as farmers, herders, or traders. With the growth of the oil industry, large numbers of people

Eleanor Abdella Doumato, the contributor of this article, is Adjunct Professor for International Studies at the Thomas J. Watson, Jr., Institute for International Studies at Brown University.

moved to cities and towns. Today, most Saudis live in urban areas, where they work in a variety of jobs. Many are employed by the government, the oil industry, and a growing number of other businesses and industries.

All people who hold Saudi citizenship are Muslims—that is, followers of the faith of Islam. Saudi Arabia holds a place of honor for all Muslims because the two holy cities of Islam—Mecca and Medina—are there. Mecca is the birthplace of the Prophet Muhammad, whose life and teachings form the basis of Islam. Medina is the city where Muhammad established the first Islamic community. Every year, millions of Muslim pilgrims from all over the world visit these cities.

For hundreds of years, the land that is now Saudi Arabia was divided among a number of groups. By the beginning of the 1900's, the eastern and western regions were under the loose control of the Ottoman Empire. The central region was ruled by local families. The country was unified during the early 1900's as the result of conquests by Abd al-Aziz ibn Saud. In 1932, Ibn Saud proclaimed this territory the Kingdom of Saudi Arabia. Saudi Arabia remained a poor nation until the mid-1900's, when income from the oil industry enabled it to begin modernization programs.

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The Palace of Justice houses the offices of the Ministry of Justice in Riyadh, the capital and largest city of Saudi Arabia. The ministry is responsible for administering the nation's courts.

The flag of Saudi Arabia includes a picture of a sword and the Muslim declaration of faith, written in Arabic.

The coat of arms features a palm tree and two swords. The symbols appear in the traditional Muslim color, green.

Government

National government of Saudi Arabia is a monarchy under the Al Saud ruling family. The king holds executive and legislative powers. As leader of the nation's spiritual affairs, he also holds the title Custodian of the Two Holy Mosques. This title refers to the Great Mosque in Mecca and the Prophet's Mosque in Medina. The king is assisted in running the day-to-day affairs of the government by the Council of Ministers. The king heads the council and serves as prime minister. He has the power to appoint and dismiss the members of the council and to overrule all its decisions.

Saudi Arabia also has a Consultative Council that consists of a chairman and 90 other members, who are all appointed by the king. The council advises the monarch on issues but has no legislative authority.

Saudi Arabia has no written constitution. But the Basic Law of Government, issued in 1992, declares the constitution of Saudi Arabia to be the Quran, the Muslim holy book, and the *Sunna*—that is, the example of the words and practices of Muhammad. The Quran and Sunna make up the Shari`a (also spelled Shari`ah), the body of Islamic law. Religious scholars known as the *ulama* interpret the Shari`a and ensure that Saudi laws follow it.

Local government. Saudi Arabia is divided into 13 provinces. The king appoints the governors of the prov-

WORLD BOOK map

Saudi Arabia is a large Middle Eastern country. It covers most of the Arabian Peninsula from the Red Sea to the Persian Gulf.

Facts in brief

Capital: Riyadh.
Official language: Arabic.
Official name: Al-Mamlaka Al-Arabiyya Al-Saudiyya (Kingdom of Saudi Arabia).
Area: 830,000 mi² (2,149,690 km²). *Greatest distances*—north-south, 1,145 mi (1,843 km); east-west, 1,290 mi (2,076 km). *Coastline*—1,174 mi (1,889 km) on the Red Sea; 341 mi (549 km) on the Persian Gulf.
Elevation: *Highest*—10,279 ft (3,133 m) above sea level, in the Asir region near Abha. *Lowest*—sea level.
Population: *Estimated 2002 population*—22,910,000; density, 28 per mi² (11 per km²); distribution, 83 percent urban, 17 percent rural. *1992 census*—16,929,294.
Chief products: *Agriculture*—barley, dates, millet, sorghum, tomatoes, wheat. *Manufacturing*—cement, fertilizer, food products, petrochemicals, steel. *Mining*—petroleum.
Money: *Basic unit*—riyal. One hundred halalas equal one riyal.

inces. Each province has a council made up of certain government officials and a number of other members appointed by the king.

Courts. Saudi laws are largely unwritten. Court rulings depend on the interpretation of the Shari`a made by each individual *qadi* (judge). A system of religious courts handles all civil and criminal cases. One or more judges preside over each court. There are no juries. There is a court of appeals, but the king himself acts as the highest court of appeal. The king also issues royal decrees dealing with legal matters not covered by the Shari`a, such as commercial and traffic regulations. In cases involving such royal decrees, local government leaders may act as judges. Specialized committees also hear some of these cases. Government decisions may be appealed to a Board of Grievances. But the board is responsible to the king and Council of Ministers.

Armed forces. A total of about 105,500 men serve in the Saudi army, navy, air force, and air defense forces. Women do not serve in the military. All military service is voluntary. A National Guard of about 77,000 men handles internal security. The United States has provided Saudi Arabia with military training and most of its modern military equipment.

People

Saudi Arabia has a population officially estimated at approximately 23 million. However, this figure cannot be confirmed because the country has never taken a reliable census. Many experts believe the actual population is much smaller.

Ancestry. The people of Saudi Arabia are racially and ethnically mixed, though a majority of the population trace their origin to Arab tribes. In the past, many African blacks were brought to Arabia as slaves. They later gained their freedom, and married Arabs and people of other ethnic backgrounds. In the western region are descendants of African, Indonesian, and Indian Muslims who originally came as pilgrims. People whose ancestors were Turkish administrators and soldiers in Ottoman times also live in the west. Saudis in the east include descendants of people from Iran, as well as descendants of African slaves.

About 25 percent of the kingdom's inhabitants are foreigners who have moved to Saudi Arabia because of the large number of jobs created by the country's oil wealth. About half of these foreign workers are from other Arab countries. The rest come from many nations, including India, Pakistan, the Philippines, South Korea, the United Kingdom, and the United States.

Language. Almost all the people of Saudi Arabia use Arabic, which is the official language of the country. English is taught in intermediate and secondary schools and is widely used among foreigners and within the business community.

Way of life

The development of the oil industry has caused many advances in the Saudi way of life, especially in the cities. The country has used much of its oil income to build schools, transportation systems, and communication networks. The government has also taken steps to improve housing and to extend electric service and other modern conveniences to remote rural areas.

Family ties are strong among most Saudis. Although a Saudi father is considered the head of his family, his wife has much authority in running the household.

Outside the home, Saudi women have traditionally had little freedom or opportunity for personal advancement. As the country has developed economically, however, it has undergone a number of social changes as well. Some of these changes have affected the way of life of Saudi women, especially in the cities. Before 1960, few women received any formal education, and almost no women held jobs outside the home. Since then, the government has improved educational and employment opportunities for women. Increasing numbers of women work in such fields as teaching, medicine, and

© Ray Ellis, Photo Researchers

People of Saudi Arabia are racially and ethnically mixed. However, a majority of the people trace their roots to Arab tribes. Many of the people in this busy shopping area of Riyadh are wearing traditional Arab garments.

Saudi Arabia map index

Cities and towns

Abha	112,316	E	2
Ad Dammam	482,321	C	4
Ad Darb		E	2
Ad Dawadimi		C	3
Afif		C	2
Al Bad		B	1
Al Birk		E	2
Al Hufuf, see Hofuf			
Al Jawf		B	2
Al Jubayl	140,828	B	4
Al Kharj	152,071	C	4
Al Khubar	141,683	C	4
Al Khurmah		D	2
Al Lith		D	2
Al Madinah, see Medina			
Al Mubarraz	219,123	C	4
Al Qadimah		D	2
Al Qatif		C	4
Al Qaysumah		B	3
Al Qunfudhah		E	2
Al Quwayiyah		C	3
Al Ula		C	1
Al Wajh		C	1
An Nabk		A	1
Ar Rass		C	3
Ar Riyad, see Riyadh			
Araar	108,055	A	2
As Sulayyil		D	3
At Taif	416,121	D	2
At Turayf		A	2
Buraydah	248,636	C	3
Dariyah		C	3
Dhahran		C	4
Hafar al Batin	137,793	B	3
Hail	176,757	B	2
Haql		B	1
Harad		C	4
Hofuf (Al Hufuf)	225,847	C	4
Jidda	2,046,251	D	2
Khamis Mushayt	217,870	E	2
Khaybar		C	2
Khuff		C	3
Khurays		C	4
Layla		D	3
Makkah, see Mecca			
Mecca (Makkah)	965,697	D	2
Medina (Al Madinah)	608,295	C	2
Najran		E	3
Qalat Bishah		D	2
Qizan		E	2
Rabigh		D	2
Rafha		B	3
Ras Tanura		C	4
Riyadh (Ar Riyad)	2,776,096	C	3
Rumah		C	3
Tabuk	292,555	B	1
Tayma		B	1
Turabah		D	2
Umm Lajj		C	1
Unayzah		C	3
Yanbu	119,819	C	1
Zahran		E	3

Source: 1992 census.

WORLD BOOK map

social work. They also hold jobs in journalism, administration, and research, and in shops and banks that provide goods and services only to other women. But the activities of Saudi women are still restricted in various ways. For instance, women are not allowed to drive cars or to travel without permission of a male guardian.

City life. Modern homes and high-rise buildings stand in Saudi cities and have replaced nearly all the mud houses of earlier times. People in the cities work in a variety of occupations and industries. Many have jobs in government service and in industry.

Socializing with friends and family remains the most popular form of entertainment. Public movie theaters are not allowed, but radio, television, and home videos are popular. Many Saudi men enjoy traditional sports, such as camel racing and horse racing. They also play basketball, soccer, and volleyball.

Rural life. Most rural Saudis follow a simple way of life. Many of Saudi Arabia's rural people live in farm villages or oasis settlements. A smaller number are either *nomads* (traveling herders) or seminomads. The nomads, called Bedouins, move through the deserts with their herds of camels, goats, and sheep in search of water and pastureland. The seminomads follow a nomadic way of life part of the year but spend several months in rural settlements. The vast majority of nomads and seminomads have now become settled farmers or have moved to urban areas. There, the men have found a variety of work, including jobs as taxi drivers, oil laborers, National Guardsmen, and police officers.

A typical Saudi farm village consists of a cluster of houses made of stones or sun-dried mud. The Bedouins live in large tents made of goat hair. The village marketplace serves as a social center. There, farmers and Bedouins gather to buy and sell goods and to chat with friends.

Clothing. Most Saudis, in both urban and rural areas, wear traditional Arab clothes. Men wear an ankle-length cotton or wool garment called a *thawb* (also spelled *thobe*), which may be covered by a jacket or cloak. A

head covering called a *ghutra* provides protection against the sun and wind. It consists of a piece of cloth held in place by a rope band called an *iqal* (also spelled *igal*). Outside, most women cover their hair with a scarf and their face with a veil, and they wear a floor-length robe called an *abayah*.

Food and drink. Dairy products, dates, lamb, bread, and rice are the chief foods in a traditional Saudi diet. Supermarkets in the major towns and cities of Saudi Arabia offer a wide variety of imported and locally produced foods, including fresh fruits and vegetables. Tea and coffee are the most popular beverages. The laws of Islam forbid the eating of pork and the drinking of alcoholic beverages.

Religion. More than 90 percent of all Saudis belong to the Sunni branch of Islam. Members of the Shiah, another branch, live mainly in the Eastern Province. The only non-Muslims in Saudi Arabia are foreigners.

Islam influences family relationships, education, and many other aspects of life in Saudi Arabia. Most Saudis follow a conservative interpretation of Sunni Islam called Wahhabism. The Wahhabis believe that Muslims are obliged not only to understand the laws of God and live accordingly but also to encourage their neighbors in fulfilling God's laws. Therefore, Islamic rules of behavior are followed with a high degree of conformity across Saudi society. A religious police force, whose patrolmen are called the *mutawwiin,* helps enforce the rules of behavior. For example, the mutawwiin ensure that shops close for prayer times and that people on the streets are properly dressed.

Education. A majority of the people of Saudi Arabia 15 years of age or older can read and write. For the literacy rate, see **Literacy** (table: Literacy rates).

The government provides free schooling for Saudi citizens at all levels of education. School attendance is not required by law. The first public schools were established in 1951, for boys only. Public education for girls began in 1960. Today, more than 80 percent of children of primary school age attend school, and boys and girls are enrolled in almost equal numbers. In public schools, boys and girls study a similar curriculum.

Saudi Arabia has 7 universities and about 80 colleges. King Saud University (at one time known as Riyadh University) was the kingdom's first university. It opened in 1957 with 21 students. Today, it is the nation's largest university, with about 37,000 students.

The land

Saudi Arabia consists largely of dry, barren land that slopes downward from west to east. The country has no permanent rivers or other bodies of water. During rainstorms, dry valleys called *wadis* fill with water, but the water quickly evaporates or soaks into the ground.

Saudi Arabia can be divided into five land regions. They are (1) the Western Highlands, (2) the Central Plateau, (3) the Northern Deserts, (4) the Rub al Khali, and (5) the Eastern Lowlands.

The Western Highlands border the Red Sea. The northern part of this region is called Hejaz, and the southern part is known as Asir. Along much of the Hejaz coast, low, rocky mountains rise up sharply from the sea. The mountains slope more gently toward the east. In parts of Hejaz and in Asir, a narrow coastal plain called the Tihamah separates the sea from a ridge of rugged mountain peaks. The highest peaks in Asir rise more than 9,000 feet (2,700 meters) above sea level. Asir is a fertile area, and small farm villages are scattered throughout much of this region. Farmers grow a variety of crops in the Tihamah and in terraced fields on the mountainsides.

The Central Plateau. The mountains of Hejaz and Asir slope eastward toward the Central Plateau, also called Najd. Most of this large region has little vegetation. In parts of the rocky plateau, fertile oases support large farm communities. Nomadic herders bring their animals to feed on patches of grass that grow in the region for a short time after occasional rainfall.

The Northern Deserts lie north of the Central Plateau. Most of this thinly populated region consists of a vast area of sand dunes called An Nafud. The Syrian Desert, a low-lying plain of rock and gravel, covers the northernmost area.

The Rub al Khali is a huge, sandy desert that covers about 250,000 square miles (647,500 square kilometers) of southeastern Saudi Arabia. In English, the name of this vast, desolate area is the Empty Quarter. Windswept sand dunes reach heights of nearly 1,000 feet (300 meters) in parts of the Rub al Khali. Other areas are flat. The Rub al Khali is uninhabited, except for a few groups of nomadic people who travel through it or use it for grazing their herds in the spring.

The Eastern Lowlands, also called Hasa or the Eastern Province, lie along the Persian Gulf. Salt flats extend along parts of the shallow coastline. Sand and gravel cover most of the inland plain, which holds the world's largest known deposits of petroleum. The oil industry has led to the development of Dhahran and other cities and towns in the lowlands. The region also has several fertile oases fed by plentiful natural springs that support agricultural settlements.

Climate

Most of Saudi Arabia has a hot climate the year around. The coastal regions are hot and humid during the long summers, when the average daytime temperature is over 90 °F (32 °C). Summer temperatures in the Central Plateau and the desert regions may reach 120 °F

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The Eastern Lowlands, also called Hasa or the Eastern Province, includes a vast plain covered largely by sand and gravel. Much of the land of Saudi Arabia is dry and barren.

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Asir is a fertile region in southwestern Saudi Arabia. Farmers in the area use terraced fields to grow crops on the hills and mountains that cover much of the region.

(49 °C). But these areas have drier air and cool nights. From November to April, temperatures throughout the country are lower than in summer. Winter temperatures in parts of central, northern, and western Saudi Arabia occasionally dip below freezing.

Asir is the only part of Saudi Arabia that receives significant rainfall. Seasonal winds called *monsoons* bring rain to Asir and cause an average annual rainfall in the range of 12 to 20 inches (30 to 51 centimeters). The rest of the country receives less than 4 inches (10 centimeters) annually. Parts of the desert regions of Saudi Arabia may have no rainfall at all for several years in a row. A northwesterly wind called the *shamal* causes frequent sandstorms, called *sumoom,* in eastern Saudi Arabia.

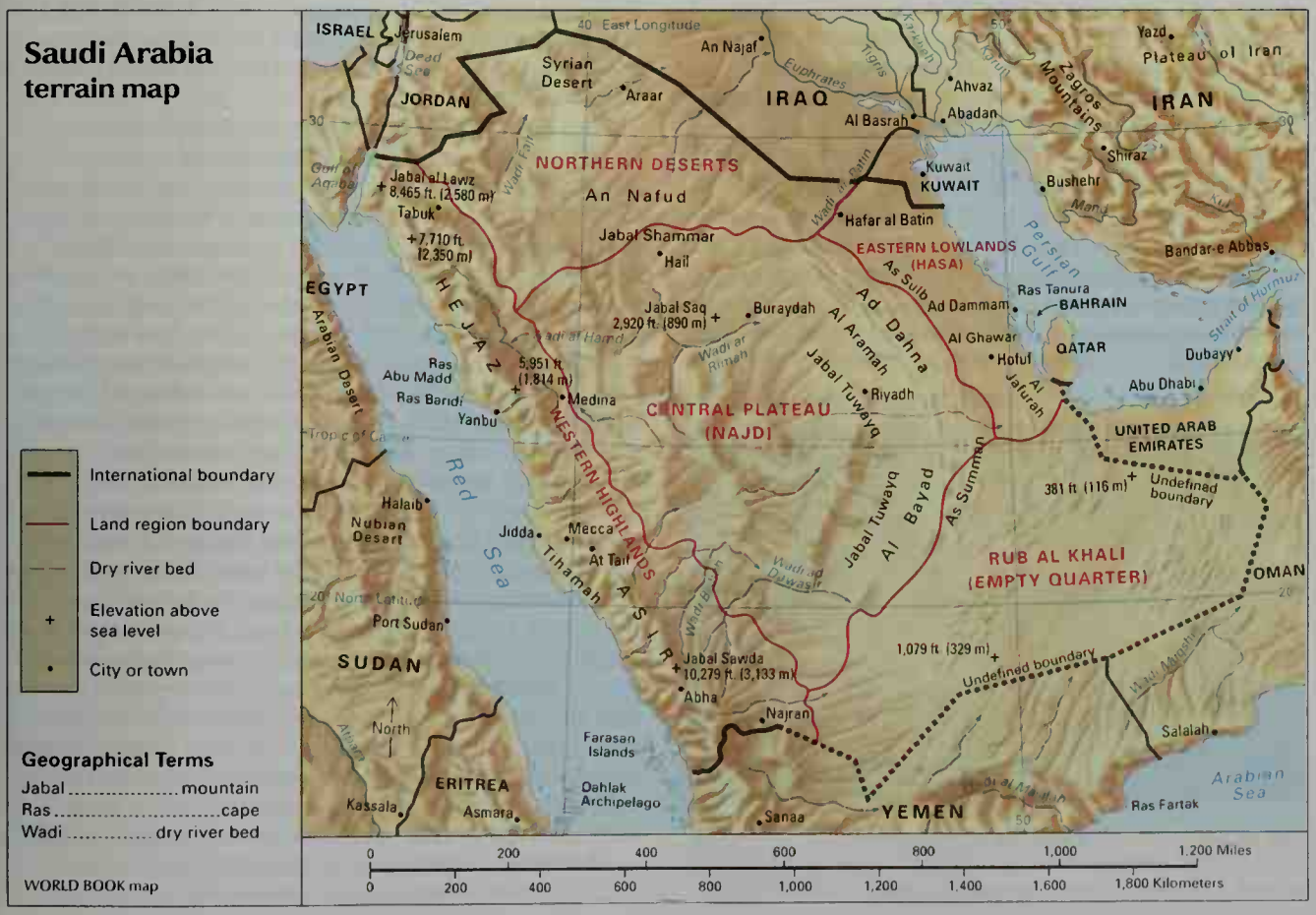
Economy

Saudi Arabia has experienced a period of rapid development since the price of oil rose sharply in the mid-1970's. Recognizing that the oil reserves are limited, however, government planners have encouraged the development of agriculture and new industries to keep the Saudi economy strong when the oil resources eventually run out.

Natural resources. Saudi Arabia has the largest reserves of petroleum in the world. The country's huge oil fields contain about 260 billion barrels of oil—about a fourth of the world's oil reserves. The richest oil fields are in the Eastern Province and in the Persian Gulf. Saudi Arabia also has small deposits of gold in Hejaz. There are deposits of cadmium, copper, iron, lead, platinum, silver, and zinc, but they are largely undeveloped. The country also has clay, gypsum, and limestone.

Saudi Arabia has no permanent rivers or bodies of fresh water, and, as a result, obtaining adequate water has been a constant challenge. The main source of water for Saudi agriculture is a huge reservoir that runs underground from the eastern highlands of Turkey. Desalination plants in the Red Sea and the Persian Gulf provide much of the water for Saudi cities and towns. Desalination plants remove salt from seawater.

The oil industry. Saudi Arabia is the world's largest exporter of petroleum and a leading producer of natural gas. It plays a leading role in the Organization of the Petroleum Exporting Countries (OPEC) The oil indus-



try is owned by the state and largely operated as the Saudi Arabian Oil Company (Saudi Aramco).

Agriculture. Cattle, goats, and sheep are important sources of dairy products and meat. Chickens and eggs are also produced. Only about 1 percent of Saudi Arabia's land is used to grow crops. The chief cultivated areas include Asir in the southwest and the scattered oases of central and eastern Saudi Arabia.

Farmers grow a number of crops, including barley, citrus fruits, dates, millet, sorghum, tomatoes, watermelons, and wheat. The introduction of modern irrigation techniques during the mid-1900's has enabled Saudi farmers to produce higher yields and a greater variety of crops. Even so, Saudi farmers cannot yet produce all the food the country needs. As a result, Saudi Arabia still imports a large percentage of its food.

Other industries. A number of major industries in Saudi Arabia, like the petroleum industry, are owned by the state. The large Saudi Basic Industries Corporation (SABIC), which is mostly government owned, operates plants that produce a variety of products, including chemicals, fertilizers, and steel.

Saudi Arabia draws few tourists. However, the millions of pilgrims who visit Mecca annually provide a substantial amount of income.

Transportation and communication. A good road system connects various parts of Saudi Arabia. A railway operates between Riyadh and the Persian Gulf port of Ad Dammam. The government owns and operates Saudi Arabian Airlines. Ad Dammam, Dhahran, Jidda, and Riyadh have international airports. Ras Tanura, a Persian Gulf port, handles most of Saudi Arabia's oil exports. The country's other major ports include Ad Dammam and the Red Sea ports of Jidda and Yanbu.

Saudi Arabia has about 10 daily newspapers. Three are published in English, the others in Arabic. Most families own at least one radio and television set, and satellite dishes are common in the cities.

International trade. Petroleum accounts for about 90 percent of Saudi Arabia's exports. Exports other than oil include chemicals, plastics, and processed foods. Leading imports include automobiles, chemicals, electrical equipment and appliances, food products, machinery, military equipment, and textiles. The country's chief trading partners include Japan, the United Kingdom, and the United States.

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The oil port of Ras Tanura lies on the Persian Gulf, near Saudi Arabia's large petroleum deposits. Huge storage tanks hold the oil until it is pumped into oceangoing tankers docked offshore.

History

For thousands of years, people in what is now Saudi Arabia have adapted their way of life to conditions of the land. In oasis settlements, where water was available, the ancient inhabitants carried out small-scale agriculture. Herders raised sheep and goats in nearby desert pasture. With the domestication of the camel, an animal that can survive for days without water, people began to transport goods across the desert and to live as nomads.

In coastal areas, trade centers linked the peninsula to East Africa, India, Mesopotamia, and the Mediterranean. From the mid-400's B.C. to about A.D. 100, the Nabataen kingdom in the north controlled the trade routes in what are now northwestern Saudi Arabia and Jordan. The kingdom of Saba (called Sheba in the Bible) developed in the southern part of the peninsula, in what is now Yemen. About 700 B.C., the kingdom became a trade center for frankincense, myrrh, and spices.

The rise of Islam. Muhammad, the prophet of Islam, was born in Mecca about A.D. 570. At that time, most of the people of the Arabian Peninsula worshiped many gods. But especially in the northwest, near the present-day Medina, there were also some Christians and many Jews, who worshiped only one God. Muhammad, too, taught that there was only one God and that there would be a day of judgment when people would have to answer for their misdeeds.

As Muhammad attracted followers, he made enemies of the wealthy classes in Mecca. In 622, he and a few followers left Mecca for Medina. His emigration from Mecca to Medina is known as the Hijra, also spelled Hegira. In Medina, he became the spiritual and political head of a new Muslim community. He returned with an army and captured Mecca in 630. By the time Muhammad died in 632, much of the Arabian Peninsula was under Muslim rule.

After Muhammad's death, his successors, called *caliphs,* conquered the rest of Arabia and an area stretching from Egypt to Iran. Eventually, the empire extended as far east as India and across North Africa as far west as Spain. In 661, the caliph Muawiya established his capital in Damascus, in present-day Syria. In 762, the capital moved to Baghdad, in what is now Iraq. Though the political center of the Muslim empire had shifted out of Arabia, Medina remained a hub of intellectual life. One of the four schools of Islamic law had developed in Medina. Hejaz, which holds the sites of the Muslim pilgrimage, remained the spiritual center of Islam.

Beginning in the late 900's, Hejaz fell under the rule of Muslim dynasties in Egypt. In the early 1500's, the Ottoman Empire gained control over Hejaz and parts of Asir in western Arabia. The Hejaz cities developed an international, cosmopolitan character because of their attraction as a pilgrimage center. Najd, by contrast, was isolated by deserts and a mountain range that separated it from Hejaz. Najdi villages remained under local control, and huge, nomadic tribal confederations maintained their independence and their own system of government. Hasa in the east became a Shiite center during the 800's. It came under the control of the Ottomans from the 1500's to the mid-1600's and again in the 1800's.

The Saud dynasty. About 1500, the Saud *dynasty* (family of rulers) established control over a small area

around the village of Dariyah (also spelled Diriyah), near what is now Riyadh. In the mid-1700's, a leader named Muhammad ibn Saud formed an alliance with the religious reformer Muhammad ibn Abd al-Wahhab.

Ibn Abd al-Wahhab believed that Muslims should follow a strict interpretation of the Islamic law found in the Quran and sunna. He condemned the custom of visiting the tombs of saints and other practices as departures from true Islam as originally taught by Muhammad. He also thought that people should be educated in religion so that they could understand what God expects of them. Ibn Abd al-Wahhab and Muhammad ibn Saud turned Dariyah into a center of religious learning. Teachers in Dariyah trained missionaries, who were sent out to convert the Bedouins and the villagers. The missionaries were followed by the army of the Saudi rulers.

By 1806, the Saudis and their religious movement controlled Najd, Mecca, Medina, and most of the east coast of the peninsula. They had begun to make raids into Iraq and Syria. Acting on behalf of the Ottoman government, a son of the governor of Egypt drove the Saudi forces back to Dariyah. He captured the town in 1818. The reigning Saudi ruler was taken to Istanbul, the capital of the Ottoman Empire, where he was executed. Dariyah was destroyed. By forming loose alliances with tribal leaders, the Saud family regained control of most of Najd within a few years and moved their capital to Riyadh. In 1891, a member of the Al Rashid family of northern Najd captured Riyadh. The leaders of the Saud family fled to Kuwait.

The founding of Saudi Arabia. In 1902, Abd al-Aziz ibn Saud, one of the young Saudis who had fled to Kuwait, led a military raid and captured Riyadh. During the next 25 years, Ibn Saud, as he became known, fought to regain the territory that his ancestors had controlled. His forces captured Hasa in 1913. They gained control of most of Asir in 1920. They defeated the Al Rashid in northern Najd in 1921. In 1924 and 1925, Ibn Saud took over Hejaz, and in 1932, he proclaimed the lands under his control as the Kingdom of Saudi Arabia.

Ibn Saud's success was due largely to his revival of the Wahhabi movement. The forces used in his conquests were called the Ikhwan (Brothers). They were former Bedouins who had converted to Wahhabi beliefs and settled on the land in agricultural and religious communities known as *hujar* (also spelled *hijar*). In the conquered territories and in the hujar, the Ikhwan tried to enforce strict Islamic observances. Ibn Saud eventually broke the power of the Ikhwan, but their zealousness as Wahhabi Muslims has left its mark on the character of Saudi society to this day.

The new kingdom formed by Ibn Saud was isolated and undeveloped. Most of the people were poor farmers or nomads who lived much as their ancestors had lived for hundreds of years before them.

The development of Saudi Arabia's oil industry began in 1933. That year, Ibn Saud's government granted Standard Oil of California, an American oil company, the right to explore for and produce petroleum in Saudi Arabia. Other oil firms later joined the California company. These companies became the Arabian American Oil Company (Aramco) in 1944. A major petroleum deposit was discovered in 1938, but large-scale production did not begin until after World War II ended in 1945.

After the war, the oil industry developed rapidly and brought wealth to Saudi Arabia. Aramco paid the Saudi government a share of its profits in return for the right to produce and sell oil. Ibn Saud began economic and social programs in Saudi Arabia. The Saudi government and Aramco built many roads, schools, and hospitals.

In 1953, Ibn Saud organized a Council of Ministers as a step toward modernizing the government. Later that year, Ibn Saud died, and his oldest son, Saud, became king of Saudi Arabia. Saud's brother Faisal became crown prince and prime minister. Saud continued the development programs begun by his father. But Saud's government spent money unwisely. As a result, the country faced serious economic problems by the late 1950's. In 1958, Saud gave Faisal control over the government. Faisal restored economic stability. But he resigned as prime minister in 1960 due to disagreements with Saud. Saud again took control of the government.

In 1962, a civil war in Yemen (Sanaa), now part of Yemen, caused a crisis between Saudi Arabia and Egypt. Yemeni military leaders had overthrown their government and set up a republic. Egypt supported these rebels, while Saudi Arabia backed Yemeni royalists who fought to restore the former government. The conflict threatened to become a war between Saudi Arabia and Egypt. Tension continued until 1967, when Egypt withdrew its forces from Yemen (Sanaa).

In the early 1960's, Saud's health weakened, and with it his ability to rule. In 1962, Faisal again became prime minister. In 1964, a council of royal family members and religious leaders forced Saud to give up the throne. They then made Faisal king.

Continued progress. Profits from the oil industry financed the construction of hospitals, schools, and apart-

Important dates in Saudi Arabia

c. 570 Muhammad, prophet of Islam, was born in Mecca.

c. 1500 The Saud family established control over a small area around Dariyah, near present-day Riyadh.

1500's The Ottoman Empire gained control over Hejaz and parts of Asir.

Mid-1700's The Wahhabi movement, which urged strict observance of Islamic laws, spread across most of Arabia. The Saud family supported and helped spread the movement and took over a large part of the Arabian Peninsula.

1891 Tribal leaders and the Ottomans gained control of most of Arabia. Leading members of the Saud family fled in exile.

1902-1932 Abd al-Aziz ibn Saud, an exiled Saudi leader, conquered the Najd, Hasa, Asir, and Hejaz regions and formed the Kingdom of Saudi Arabia.

1933 The Saudi petroleum industry began.

1967 Saudi Arabia supported Egypt, Jordan, and Syria in the Six-Day War against Israel.

1973 Saudi Arabia stopped or reduced oil shipments to some Western nations after another Arab-Israeli war broke out.

1975 Faisal, king of Saudi Arabia since 1964, was assassinated. He was succeeded by his half brother Prince Khalid.

1982 Khalid died and was succeeded by his half brother Prince Fahd.

1991 Saudi Arabia and a coalition of other nations defeated Iraq in the Persian Gulf War.

ment buildings. The government improved and expanded the country's transportation and communication systems. At the same time, Saudi Arabia began to take a more active interest in Arab and world affairs.

Following the start of the Six-Day War between Israel and Egypt, Iraq, Jordan, and Syria in June 1967, Faisal sent troops to Jordan and Syria. However, they were not involved in combat. The Six-Day War left Israel in control of the entire Sinai Peninsula, the Golan Heights of Syria, and the Gaza Strip. Israel also controlled the West Bank—that is, all the territory previously held by Jordan west of the Jordan River. This land included part of Jerusalem, one of Islam's holiest cities. Faisal took a strong stand against this Israeli occupation.

After another Arab-Israeli war broke out in 1973, Faisal used Saudi Arabia's oil as an economic weapon against nations supporting Israel. Saudi Arabia and several other Arab oil-producing countries temporarily stopped exporting petroleum to the United States and the Netherlands. They also reduced oil shipments to other countries they classed as "neutral." The cutback created serious fuel shortages in many countries.

In 1973, the Saudi government took over part-ownership of Aramco's oil facilities. In 1980, the government completed payment for ownership of Aramco's oil facilities and assets. The take-over of the company by Saudi Arabia became official when the Saudi Arabian Oil Company (Saudi Aramco) was formed in 1988.

In the mid-1970's, oil prices jumped sharply, causing a dramatic increase in Saudi Arabia's wealth. The added income enabled the government to devote huge sums of money to new projects. In 1974, Saudi Arabia and the United States signed an agreement to cooperate in such areas as education, science and technology, agriculture, and industrialization.

In March 1975, King Faisal was assassinated by one of his nephews. Prince Khalid, a half brother of Faisal, succeeded Faisal as king and prime minister. Khalid made his half brother Prince Fahd crown prince and first deputy prime minister. Khalid died in 1982, and Prince Fahd became king and prime minister.

Khalid and Fahd generally continued Faisal's policies. Saudi Arabia continued to take an active role in Arab and world affairs. Rapid construction of transportation and communication facilities continued, and industry expanded. But a sharp decline in worldwide oil prices reduced the country's income. The government began to put more emphasis on developing human resources and less on constructing physical facilities. These policies included steps to increase the training of Saudi people in skills needed for management and technical jobs.

The Persian Gulf War. In 1990, Iraqi forces invaded and occupied Kuwait. Saudi leaders feared that Iraq would next try to take over the oil fields in the Eastern Province. A number of nations opposed to the Iraqi occupation joined Saudi Arabia in a military operation to drive Iraq out of Kuwait. The allies included Egypt, Syria, and several other Arab nations, as well as the United States, the United Kingdom, and other Western nations.

In January 1991, the allied operation against Iraq began. The United States provided a majority of the fighting personnel and equipment. Saudi Arabia provided the staging area for the attack, called the Persian Gulf War. The Saudis contributed military and communications equipment; housing for aircraft, military personnel, and arms; and most of the financial resources. By the end of February, Saudi Arabia and its allies had driven the Iraqis out of Kuwait. Though a military success, the Persian Gulf War became controversial in Saudi Arabia. It contributed to a rise in conservative and anti-American sentiment there. The cost of the war also forced the Saudi government to reduce spending on social and economic programs.

Recent developments. In the late 1990's, King Fahd's health began to decline. His half brother Crown Prince Abdullah became increasingly responsible for running the Saudi government.

Eleanor Abdella Doumato

Related articles in *World Book* include:

Arab-Israeli conflict	Clothing (Traditional costumes)	Islam
Arab League	Fahd	Jidda
Arabian Desert	Faisal	Kaaba
Arabian Peninsula	Food (picture)	Mecca
Arabs	Gulf Cooperation Council	Medina
Bedouins	Ibn Saud	Muhammad
Bin Laden, Osama		Petroleum (graph)
		Riyadh

Outline

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V. Climate

VI. Economy
- A. Natural resources
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- C. Agriculture
- D. Other industries
- E. Transportation and communication
- F. International trade

VII. History

Questions

What is the English name for the Rub al Khali?
When did the oil industry begin to develop rapidly in Saudi Arabia? How has this industry affected the nation?
What provides much of the water for Saudi cities and towns?
What is Wahhabism?
What role does Islam play in Saudi life?
What is an *abayah*? a *wadi*? a *ghutra*?
What is Saudi Arabia's chief natural resource?
When was the Kingdom of Saudi Arabia officially proclaimed?
What two cities in Saudi Arabia are important to Muslims? Why?
What are some of Saudi Arabia's natural resources besides oil?

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Sauk Indians, *sawk* or *sak,* also spelled *Sac,* belonged to the Algonquian language group of the North American Eastern Woodlands tribes. They lived with their close relatives, the Fox. They originally made their home in Canada or Michigan, but the Iroquois drove them out. They then settled in southern Wisconsin, northern Illinois, and Iowa. The Sauk had a large village where Rock Island, Illinois, now stands. They also set up villages in Iowa along the Mississippi River.

The Sauk and Fox lived in lodges covered with elm bark. When hunting away from the village in winter, they lived in round houses made of stakes covered with matting. The men wore skin clothing long after cloth was available from white traders.

The Sauk and Fox ceded their Illinois lands to the United States in 1804, and most of them moved across the Mississippi. But a famous warrior, Black Hawk, tried to regain the Rock Island village. This attempt led to the Black Hawk War in 1832 and the defeat of his band (see **Black Hawk**). Most Sauk and Fox now live in Iowa and Oklahoma. R. David Edmunds

Saul, the first king of Israel, reigned from about 1029 to about 1000 B.C. The dramatic story of his life and times is contained in the Bible (I Samuel 9-31).

Israel's existence as a nation was threatened by the Philistines, who had mastered the new technique of fabricating iron and had a monopoly of iron weapons. Israel's old system of government under casually chosen judges was not equal to the situation. The people clamored for a king, and the old ruling group reluctantly gave in and picked Saul for the task. At this time, he was only a young member of an insignificant clan.

Saul surprised everybody with his ability. He was brave, generous, and modest, and he would not take orders blindly from the old guard. But the mounting pressures and responsibilities of ruling slowly undermined his personality. He became moody and suspicious, and grew jealous of young David's growing popularity.

Saul won many victories, but when the final test came, at the battle of Mount Gilboa, his outnumbered and poorly equipped army was no match for the Philistines. Mortally wounded, he fell on his sword. He was mourned by friend and foe alike. Gary G. Porton

See also **David**.

Saul of Tarsus. See Paul, Saint.

Sault Sainte Marie, *SOO SAYNT muh REE,* Ontario (pop. 74,566), stands on the St. Marys River, which connects Lake Superior and Lake Huron (see **Ontario** [political map]). The French founded a settlement on the north bank of the river in 1668 and named it for the rapids in the river. The Old French word *sault* means *rapids* or *falls.* The rapids provide hydroelectric power for the city and for industries that make iron and steel, pulp and paper, and lumber. Engineers built an international railway bridge between Sault Ste. Marie, Michigan, and Sault Ste. Marie, Ontario, in 1887 and a canal in the river in 1895 (see **Soo Canals**). A highway bridge between the two cities was completed in 1962. In the late 1900's, the city replaced some industrial sections on the downtown waterfront with retail and recreational facilities.

Donald G. Cartwright

Sauna, *SAW nah* or *SOW nah,* is a special kind of bath for cleansing and relaxation. It causes perspiration by means of dry heat. The word *sauna* also refers to the room or bathhouse in which people take such a bath. Sauna has been a tradition in Finland for more than 1,000 years. In the United States, it is a feature of many health clubs, hotels, resorts and apartment buildings, and some private homes.

In a sauna, stones are heated on top of a furnace. The temperature in the room ranges from 176 to 212 °F (80 to 100 °C). Bathers sit or lie on wooden benches and perspire freely. They may pour water on the rocks to produce vapor and make the sauna feel hotter. Next, the bathers take a cold shower or swim and then may repeat the entire process several times. Finally, they rest until their body temperature returns to normal.

The sauna process produces an invigorating feeling. But elderly people and people with a history of ill health should consult a physician before using a sauna.

No one knows when or where sauna was developed. The Finns may have brought it to northern Europe from their previous home in central Asia. Brian V. Reed

See also **Bath** (picture: A sauna).

Saurischian. See **Dinosaur**.

Sausage is a food made of chopped and seasoned meat. The meats used in making sausage include beef, game, pork, poultry, veal, and—in some countries—fish. Sausage is seasoned with herbs and spices, including salt, red and black pepper, sage, garlic, onions, sugar, and ginger. Most sausages contain some kind of cereal, which acts as a binder, and small amounts of curing agents called *nitrites.* Nitrites give sausages their color and also help prevent the growth of bacteria that cause a type of food poisoning called *botulism.* Europeans sometimes add gin or red wine to the sausage they make to give it a special flavor.

Most sausage meat is pressed into a long, round *casing* (skin). Natural sausage casings are made from the intestines of farm animals, especially sheep. Before these casings are used, they are cleaned and salted, or soaked in brine. Sausage casings made of cellulose materials are often used (see **Cellulose**). Skinless frankfurters are sausages that have had their casings removed.

Sausage meat and sausages are important products of the packing industry. People also make sausage at home. Fresh sausages are sold raw and may be boiled, fried, or broiled. Other types of sausage include uncooked, smoked sausages, such as country-style sausage links; cooked sausages, such as frankfurters; semidry sausages, such as salami; dry sausages, such as pepperoni; and specialty meats, such as luncheon meats.

The frankfurter, named for Frankfurt (am Main), Germany, is the most popular sausage. Experts believe frankfurters were first made in Germany during the Middle Ages. Frankfurters are also called *hot dogs, red hots,* and *wieners* in North America. American frankfurters can be made of cured and well-smoked beef, pork, poultry, or a combination of meats. Frankfurters served in buns are a favorite American food. Vienna sausage, or *wienerwurst,* looks like a frankfurter but is shorter. This

sausage is named for Vienna (Wien), Austria.

George C. Skelley

See also Meat packing (picture: A frankfurter machine).

Sauvé, *soh VAY,* **Jeanne Mathilde,** *zhahn ma TEELD* (1922-1993), became the first woman to serve as governor general of Canada. She was governor general from 1984 to 1990. Sauvé succeeded Edward R. Schreyer in the position. She also was the first woman to serve as speaker of the House of Commons.

Sauvé was born in Prud'homme, Saskatchewan. She graduated from Notre Dame du Rosaire Convent, a college in Ottawa, and also studied at the University of Paris. In 1950, she began working for UNESCO, an agency of the United Nations. From 1952 until 1972, she worked mainly as a journalist and broadcaster for newspapers and radio and television networks in Canada. In 1972, Sauvé was elected to the House of Commons. Prime Minister Pierre Elliott Trudeau appointed her minister of state for science and technology in 1972, minister of the environment in 1974, and minister of communications in 1975. Sauvé served as speaker of the House of Commons from 1980 to 1984. J. L. Granatstein

Savanna, *suh VAN uh,* also spelled *savannah,* is a grassland with widely scattered trees and shrubs. Most savannas are in the tropics and lie between deserts and rain forests. Certain grasslands in temperate areas are also sometimes called savannas. This article discusses tropical savannas. For information about other savannas, see **Forest** (Temperate savannas).

Savannas cover more than two-fifths of Africa and large areas of Australia, India, and South America. They occur in regions that have both rainy and dry seasons.

Most savannas receive from 30 to 40 inches (76 to 100 centimeters) of rain annually. But some get as little as 10 inches (25 centimeters) of rain, and others get as much as 60 inches (150 centimeters). Grasses on the driest savannas, where trees are widely scattered, grow only a few inches high. On more humid savannas, grasses grow several feet tall, and trees are more abundant. Grasses on the wettest savannas may reach heights of 10 feet (3 meters) or more.

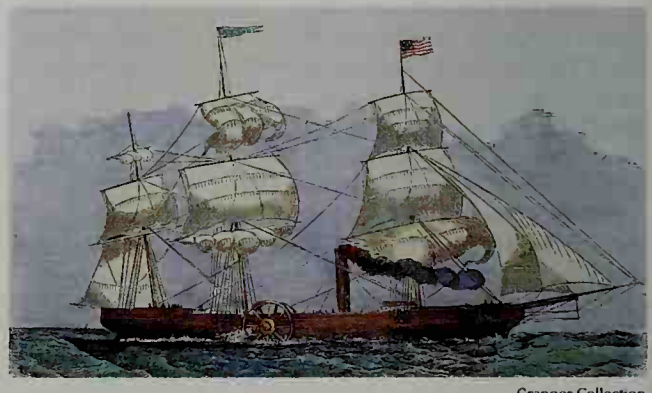
Most savanna grasses grow in clumps and do not form a continuous cover of sod. Other nonwoody plants, including members of the composite and legume families, grow among the grasses. Acacias, baobabs, and palms are some common savanna trees.

The growth of trees on savannas is limited by the dry season, which may last up to five months. When the dry season begins, grasses stop growing and turn brown, and most trees shed their leaves. Only the most drought-resistant trees can survive. During the dry season, frequent brush fires destroy many young trees. Grasses have extensive root systems that survive the fires and send up fresh shoots as soon as the rains return. On some savannas, poor drainage and other soil conditions also favor the growth of grasses instead of trees.

A wide variety of animals live on savannas. Large herds of antelope and zebras graze on the African savannas. Cheetahs, hyenas, lions, and other meat-eaters prey on these animals. Many rodents, birds, reptiles, and insects also inhabit savannas. Phillip L. Sims

See also **Africa** (Deserts, grasslands, and forests); **Forest** (map: Forests of the world; picture); **Grassland**.

Savannah was the first steamship to cross the Atlantic Ocean. The *Savannah* sailed from Savannah, Georgia, on May 22, 1819, and docked in Liverpool, England, on June 20, 1819. It was driven by steam for 105 hours. Sails were used the rest of the time. See also **Ship** (Oceangoing steamships). Philip Chadwick Foster Smith

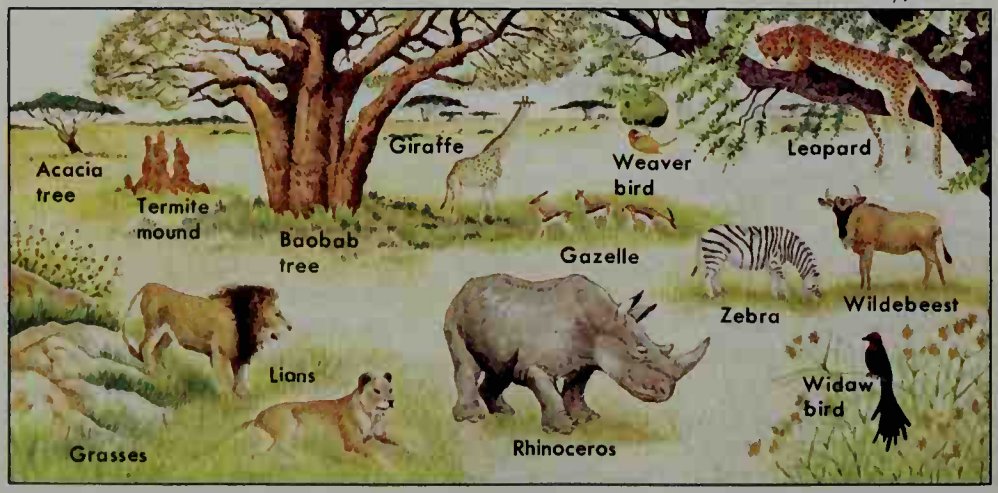


Granger Collection

The *Savannah* used both steam and sails for power.

Savannah, Georgia (pop. 131,510; met. area pop. 293,000), is a main port of the Southern United States. The city has one of the world's most up-to-date systems

WORLD BOOK illustration by Jean Helmer



A wide variety of animals live on savannas. Lush grasses provide abundant food for many species of grazing animals, such as gazelles and zebras. Giraffes eat leaves, twigs, and fruit from widely scattered trees. Such meat-eaters as lions and leopards prey on the grazing animals. Many kinds of birds, insects, and other small animals also inhabit savannas.

of docks and warehouses. Savannah lies in east-central Georgia. It is about 18 miles (29 kilometers) inland from the Atlantic Ocean, across the Savannah River from South Carolina. A channel 42 feet (13 meters) deep connects the city with the Atlantic Ocean. For the location of Savannah, see **Georgia** (political map). For the monthly weather in Savannah, see **Georgia** (Climate).

Hunter Army Airfield near Savannah and Fort Stewart 40 miles (64 kilometers) south of the city make up the United States Army Third Mechanized Infantry Division. Armstrong Atlantic State University, Savannah College of Art and Design, and Savannah State University are in Savannah. The city is the home of the Savannah Symphony and the Telfair Academy of Arts and Sciences, one of the leading art galleries in the region. The Bethesda Home for Boys, which is the oldest children's home in the United States, opened on its present site near Savannah in 1740. Many visitors to the area come to the home of Juliette Gordon Low, who founded the Girl Scouts in the United States.

The economy of the Savannah area is supported by farming, manufacturing, the military, the ports, tourism, and the wood products industries. The largest employers produce corporate jet planes, refined sugar, and such paper products as kraft paper, linerboard, and recycled paper products. Other major manufacturers produce building materials, chemicals, food products, transportation equipment, and ships. The city's fastest-growing economic activity is tourism.

James Oglethorpe founded Savannah on Feb. 12, 1733, as Georgia's first colonial settlement. Because of this, people call it the *Mother City of Georgia.* Savannah was one of the first planned cities in the United States. Settlers built it according to a design by William Bull and Oglethorpe. It was the chief city and capital of the Georgia colony until after the Revolutionary War ended in 1783. Eli Whitney's cotton gin, which led to a great expansion of cotton farming, was invented near Savannah in 1793. The first steamship to cross an ocean, the S.S. *Savannah,* traveled from Savannah to Liverpool, England, in 1819. In 1864, during the Civil War, General William T. Sherman ended his march to the sea when he captured Savannah (see **Civil War** [Sherman's march through Georgia]).

In 1955, residents created the Historic Savannah Foundation and began a project to restore old buildings in the city's original section. More than 1,000 houses have been restored. Savannah is the seat of Chatham County and has a council-manager form of government.

Steve Thomas

Savannah River is a waterway that forms a large part of the border between Georgia and South Carolina. Several small streams unite to form the main stream. They rise near the southern boundary of North Carolina and join on the boundary of Georgia and South Carolina, southwest of Anderson, South Carolina. The Savannah then flows southeast and empties into the Atlantic Ocean at Tybee Roads. The Savannah River is 341 miles (549 kilometers) long (see **Georgia** [physical map]). A channel 18 miles (29 kilometers) long and 42 feet (13 meters) deep leads from the ocean to the city of Savannah. Large ships can use this channel. Smaller ships can safely travel 230 miles (370 kilometers) up the river, as far as Augusta, Georgia.

The J. Strom Thurmond Dam above Augusta forms a reservoir 38 miles (61 kilometers) long. This dam supplies power to the Savannah River Plant in South Carolina.

James O. Wheeler

Save the Children is a private, nonprofit, child assistance and community development agency. Its goal is to help families and communities make lasting, positive changes in the lives of their children. The agency sponsors programs in the United States and more than 40 other countries. Projects include emergency relief, mother and child health care, early childhood education, food production, and skills training.

Save the Children was founded in 1932. Its headquarters are in Westport, Connecticut.

Critically reviewed by Save the Children

Savings and loan association is a type of savings institution in the United States. Savings and loans mainly provide funds to pay for building or buying homes. They also promote saving. Savings and loans used to be called *building and loan associations, homestead associations,* or *cooperative banks.* Some savings and loan associations are *mutual institutions*—that is, they are owned and operated by depositors. Others are owned and operated by stockholders.

Traditionally, savings and loans provided most of the funds for building, buying, or remodeling homes in the United States. Today, they still fund many home mortgages, but they also make consumer and commercial loans and invest directly in real estate.

Savings and loans also offer a wide range of other financial services for individuals and businesses. These services include checking accounts, savings accounts, individual retirement accounts (IRA's), insurance, and stock and real estate brokerage services.

The first savings and loan association in the United States opened in Pennsylvania in 1831. Savings and loan associations have their own insurance fund, called the Savings Association Insurance Fund (SAIF). Deposits in savings and loans of up to $100,000 are insured by the SAIF.

During the 1980's and early 1990's, the savings and loan industry experienced its worst financial crisis since the Great Depression of the 1930's. More than 1,000 savings and loans failed, and hundreds of others were near bankruptcy. The crisis resulted from a number of factors. They included mismanagement and fraud within the industry, competition from other types of financial service firms, poor regulation, and the failure of customers to repay their loans. Many customers could not repay loans because of an economic recession in U.S. agriculture and in the country's petroleum industries.

In 1989, the U.S. Congress passed legislation to end the crisis and to prevent such a crisis from occurring again. The legislation was designed to close or sell all the troubled savings and loans, place greater restrictions on savings and loans' activities, and restore the funds used to insure deposits in savings and loans. Ending the crisis resulted in costs to taxpayers of many billions of dollars.

James R. Barth

See also **Bank** (Savings and loan associations; Regulation of U.S. banks; The savings and loan crisis).

Savings bank is a type of savings institution most commonly found in the Northeastern United States. Savings banks offer two main kinds of savings plans—*pass-*

book accounts and *time deposits*. With a passbook account, depositors can withdraw money without giving the bank advance notice. For withdrawal of time deposits, the bank may require prior notification. The U.S. government insures each account for up to $100,000.

Nearly all savings banks were originally *mutual savings banks*—that is, nonprofit institutions that distribute any profits to their depositors as interest. Mutual savings banks are run by a board of trustees who elect their own successors. But since the mid-1980's, many savings banks have become stock savings banks, run by a board of directors elected by stockholders. The stockholders expect cash dividends from its profits.

Until 1982, the federal and state governments strictly regulated the investments of savings banks. The banks invested chiefly in long-term mortgages and government bonds. After 1982, the banks began making commercial loans and investing in high-risk corporate bonds to earn higher profits for their stockholders. These riskier investments led to the failure of many savings banks in the 1980's and early 1990's. Carol S. Greenwald

See also **Bank** (Kinds of banks).

Savings bond is a kind of bond issued by the United States government. Through the sale of savings bonds, the federal government borrows billions of dollars in small amounts from many individuals. The person who buys a savings bond agrees to lend money to the government for a certain length of time. The government agrees to pay interest on the money it borrows.

Most savings bonds today are Series EE bonds, which earn interest for 30 years. The interest rate is based on the interest rates earned on other federal securities. EE savings bonds have a *face value* of $50 to $10,000. The face value is the amount that appears on the bond. Each bond is sold at half its face value. Interest earned is added to the bond's present cash-in value. The government guarantees the bond's cash-in value will equal at least its face value by 17 years after the bond's purchase.

The Series HH savings bond pays interest for 20 years. Its holder can choose to receive an interest payment every six months. The interest rate is set when the bond is issued and can change after 10 years. HH bonds have a face value of between $500 and $10,000. They can be acquired only in exchange for EE bonds, E bonds, or certain other federal securities. The E bond is a type of savings bond that was sold from 1941 to 1980. The cash-in value of an HH bond always equals its face value.

Another type of savings bond is the Series I bond, which can be held up to 30 years. I bonds have a face value of $50 to $5,000. Each bond pays a fixed rate of interest plus a rate based on the rate of inflation. Thus, the bond's total interest rate always exceeds the inflation rate. The government also guarantees that the cash value of an I bond will never fall below its face value.

HH, EE, and I bonds can be cashed six months after they are acquired. No U.S. savings bond is subject to state or local income taxes.

The U.S. government first issued savings bonds in 1935. Today, the Bureau of the Public Debt, an agency of the Department of the Treasury, runs the savings bond program. Joanna H. Frodin

See also **National debt**.

Savonarola, *sav uh nuh ROH luh,* **Girolamo,** *jih RAHL uh moh* (1452-1498), was an Italian friar, a fiery religious reformer, and a preacher. By 1490, he had begun efforts to reform the city of Florence through preaching. He was an emotional, but effective, preacher. Savonarola's humor, charm, colorful language, and theatrical manner made him a leading figure. He claimed prophetical inspiration and criticized the immorality of Pope Alexander VI (see **Alexander VI**). Savonarola predicted punishment of the Roman Catholic Church and Italy.

Pope Alexander VI ordered Savonarola to Rome in 1495 to explain his claim to special revelation. He refused, stating that his health and fear of violence on the way prevented it. He said: "It is not the will of God that I leave Florence." The pope then forbade him to preach.

When Savonarola resumed preaching during Lent in 1496, the pope excommunicated him for disobedience. When he continued his defiance, Alexander VI threatened to place Florence under an *interdict* (ban on worship) unless the city could force him to go to Rome or could force him to be silent until he asked absolution. Savonarola surrendered to the civil authorities. He was tried and condemned by an ecclesiastical court, which turned him over to the civil authorities for punishment. Savonarola was hanged and his body burned.

Savonarola was born in Ferrara of a noble family. He joined the Dominican order in 1474. William J. Courtenay

Savoy, *suh VOY,* was, until 1946, the oldest reigning family in Europe. Humbert, count of Savoy, founded the house in the early 1000's. The family originally ruled a few small states on the slopes of the Alps in northwestern Italy. In the early 1400's, it won control of the Piedmont region of northwestern Italy. The family later acquired more land, and it extended its rule over all Italy as a result of a series of wars fought between 1859 and 1870. The family lost the Italian throne in 1946, when the people voted to make Italy a republic. See also **Victor Emmanuel II; Victor Emmanuel III.** Susan A. Ashley

Saw is a cutting tool that has a metal blade with sharply pointed teeth along one edge. Saws cut wood and almost any other material, including plastics and steel.

A saw's teeth slant alternately to the left and right. This system of slanting, called *saw set,* helps the saw move through the material being cut. As a saw cuts, the teeth remove some of the material as sawdust and form a channel wider than the blade. The blade slides through this channel, called a *kerf,* without sticking.

The size of a saw's teeth determines the smoothness of the cut. The more tooth points per inch of blade, the smaller the teeth—and the smoother the cut surface. Most saws used for cutting lumber into smaller pieces have 5 $\frac{1}{2}$ to 10 points per inch. For fine work, saws with as many as 20 points per inch may be used.

There are two main kinds of saws: (1) handsaws and (2) power saws.

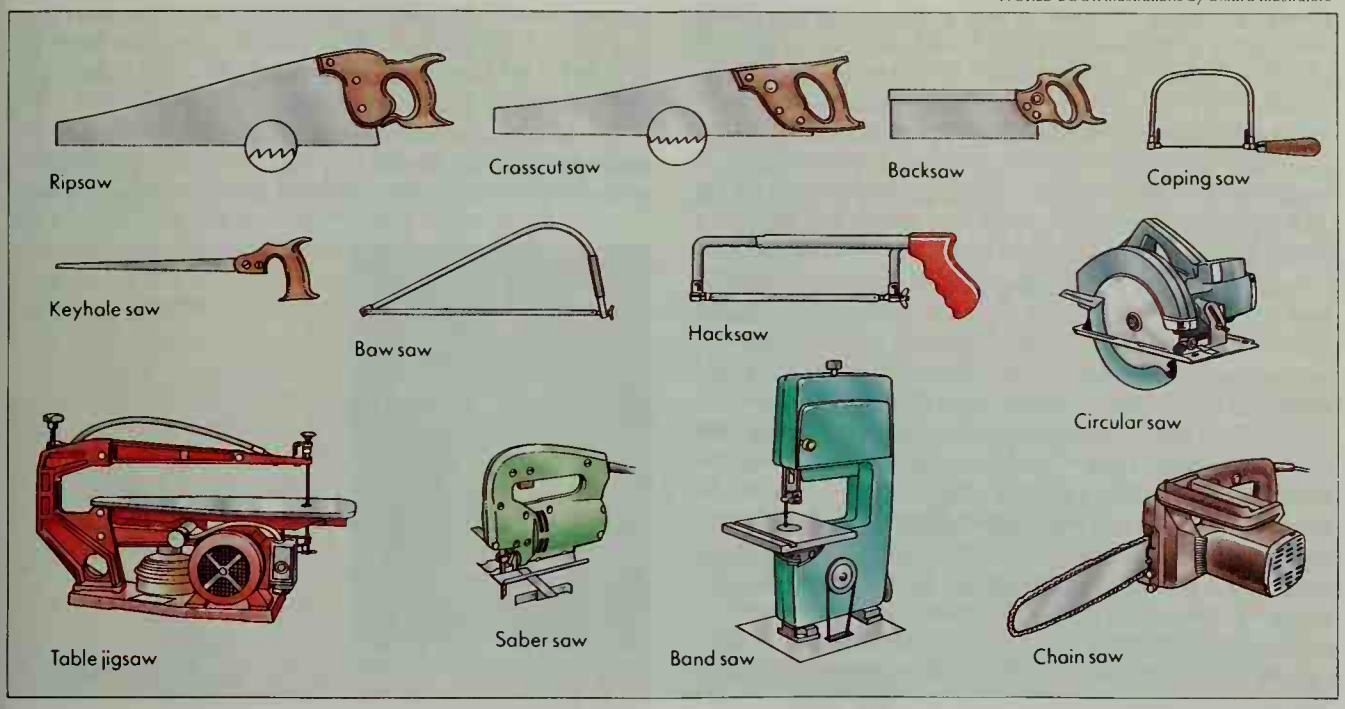
Handsaws are alternately pulled and pushed with a back-and-forth motion. Some make only straight cuts, and others make both straight and curved cuts.

Several types of handsaws may be used for straight cuts in wood. A *crosscut saw* cuts across the grain of a board. A *ripsaw* cuts lengthwise with the grain. A *backsaw* moves both across and with the grain. Craftworkers often use a backsaw along with a tool called a *miter box,* which guides the blade for accurate cuts.

To cut curves in thin boards, craftworkers may use a *coping saw.* This saw has a thin, flexible blade fastened

Kinds of saws

WORLD BOOK illustrations by Oxford Illustrators



at each end across a U-shaped frame. *Keyhole saws* and *compass saws* cut curves in thick boards. They have a narrow, rigid blade with a handle on one end.

Straight or curved cuts in metal are made with a *hacksaw.* Various replaceable blades of hardened steel cut different kinds and sizes of metal objects.

Power saws are driven by an electric motor or a gasoline engine. Some are mounted on a special table, and others are held by hand. Most power saws can be fitted with various types of blades to cut different materials. The blades of power saws move at great speed.

The most widely used type of power saw is the *circular saw.* Its disklike blade makes straight, accurate cuts. Circular saws may be table-mounted or handheld.

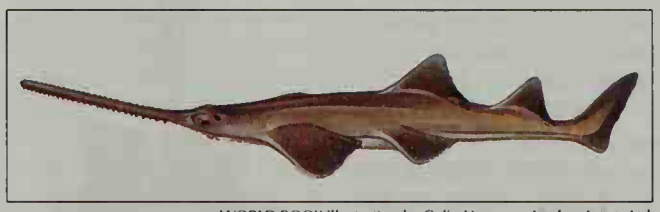
To make straight or curved cuts, craftworkers use a table-mounted or handheld *jigsaw.* This saw has a thin blade that moves up and down at high speed. A handheld *saber saw* also uses this type of motion. The *band saw* is a table-mounted power saw used for straight or curved cuts. This saw's blade is an endless flexible steel band that rotates between two large pulleys.

A handheld power saw called a *chain saw* is used to cut trees and heavy timber. The saw's teeth are attached to an endless moving chain. Alva H. Jared

See also **Lumber** (pictures); **Woodworking.**

Sawfish is the name of a family of fish with long snouts that look like saws. They belong to a group of fishes called *rays,* which have boneless skeletons made of a material called *cartilage.* Sawfishes live in tropical waters, often in bays and at the mouths of rivers.

A sawfish has a sharklike, torpedo-shaped body. Its snout has a row of long, sharp, triangular teeth on each side. The fish may grow as long as 20 feet (6 meters), including its snout, which may reach 4 feet (1.2 meters) in length. A sawfish feeds on schools of fish and sea-bottom-dwelling *invertebrates* (animals without backbones). It uses its snout to break up fish schools, to defend itself, and to force out mud-dwelling prey.



WORLD BOOK illustration by Colin Newman, Linden Artists Ltd

The sawfish, a type of ray, has a sharklike body and a long snout. The snout has a row of teeth on each edge, like a saw.

Sawfishes are often mistaken for another family of fish, the saw sharks. Both groups have similar snouts and bodies, but the saw shark has gill slits on the sides of its trunk and *barbels* (long, thin, fleshy growths) near its mouth. The sawfish's gill slits are on the underside of its body, and it has no barbels. John D. McEachran

Scientific classification. The sawfish belongs to the family Pristidae. Two species of sawfish, *Pristis pectinata* and *P. pristis,* are found along the southeastern Atlantic and Gulf of Mexico coasts of the United States and the tropical eastern Atlantic Ocean. Saw sharks make up the family Pristiophoridae.

Sawfly is an insect related to ants, bees, and wasps. Sawflies lay their eggs in the leaves and stems of plants and trunks of trees. Adult females have a sawlike organ that slits the plant tissue and pushes the egg inside. Most immature sawflies resemble caterpillars but have more legs along their abdomens. Some sawfly caterpillars gather in large numbers and may form *galls* (swellings) on plants. Adults have four membranous wings.

The most destructive North American sawflies are those that attack pine, fir, larch, and spruce trees. Other important species damage garden roses, currant bushes, wheat stems, cherry and pear trees, and birch and elm trees. Robert W. Matthews

Scientific classification. Sawflies belong to the order Hymenoptera. They are classified in several families, including Diprionidae and Tenthredinidae.

Sawmill. See Lumber.

Sawyer, Ruth (1880-1970), was an American storyteller and author of children's books. Family life, social and religious customs, and folklore are important thematic elements in her children's fiction. Sawyer won the 1937 Newbery Medal for *Roller Skates* (1936), an autobiographical story about a young girl who explores New York City on skates. Her other well-known books include *The Long Christmas* (1941), *The Way of the Storyteller* (1942), and *Journey Cake, Ho!* (1953).

Sawyer was born in Boston. In 1908, she started the first storytelling program at the New York Public Library. Sawyer helped organize kindergartens in Cuba. She worked as a storyteller in a women's prison in West Virginia and in the slums of New York City. Sawyer received both the Laura Ingalls Wilder Award and the Regina Medal in 1965. Virginia L. Wolf

Sawyer, Tom. See Twain, Mark.

Saxifrage, *SAK suh frihj,* is the name of about 300 species of hardy plants that grow in cold and temperate parts of the Northern Hemisphere. They are called *saxifrage,* which means rock-breaker, because they usually grow on or between rocks. Many saxifrages are grown in rock gardens. Most are *perennials* (plants that live for more than two years).

WORLD BOOK illustration by Lorraine Epstein

Early saxifrage

Saxifrages grow from 2 to 36 inches (5 to 91 centimeters) high. The leaves are flat and may be fleshy. They grow in a cluster at the base of the plant. The flower stalk is erect and bears clusters of white, pink, purple, or yellow flowers. The flowers usually have 5 sepals, 5 petals, and 10 stamens. The *early saxifrage* is one of the most common species. It has white flowers and blooms as early as April. It grows from southeastern Canada to Georgia and west to Missouri. Melinda F. Denton

Scientific classification. Saxifrages make up the genus *Saxifraga* in the saxifrage family, Saxifragaceae. The scientific name for early saxifrage is *S. virginiensis.*

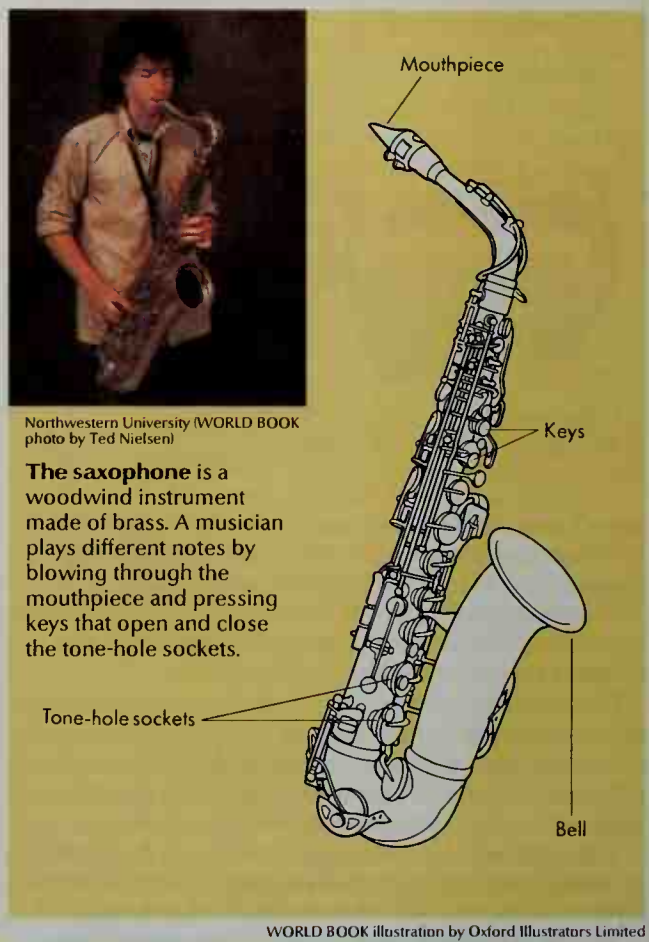
See also Currant; Deutzia; Gooseberry; Hydrangea; Mock orange.

Saxons were members of a Germanic people that invaded the island of Britain about 1,500 years ago. The Angles and the Jutes, who were also Germanic peoples, invaded Britain about the same time. These groups mixed and eventually established the Anglo-Saxon kingdom, which lasted until the Norman Conquest of 1066.

The ancient geographer Ptolemy first mentioned the Saxons in a book he wrote during the A.D. 100's. According to Ptolemy, the Saxons lived in what is now the state of Schleswig-Holstein in Germany. They were a warlike people who invaded Roman territory in the late 300's, during the reigns of the emperors Julian and Valentinian. By the 500's, the Saxons had settled in most of what is now northern Germany, between the Elbe and Rhine rivers. During the 400's and 500's, the Saxons invaded Britain, conquered the Celts there, and settled in southern and eastern Britain. In the 700's, Charlemagne conquered the Saxons still on the continent, forced them to accept Christianity, and made their land, then called *Saxony,* part of his empire. John Gillingham

See also Anglo-Saxons; England (History).

Saxophone is a woodwind musical instrument made of brass. It consists of a tube with a mouthpiece at one end and a bell-shaped opening at the other. The saxophone has holes covered by pads operated by small levers called *keys.* To play, the musician blows on a flat cane reed attached to the mouthpiece and fingers the keys to open and close the holes. The most popular saxophones, from highest to lowest range of pitch, are soprano, alto, tenor, and baritone. Adolphe Sax invented the saxophone in Paris about 1840. The instrument is popular in concert bands, dance bands, and jazz groups. It is occasionally played in orchestras. André P. Larson



Northwestern University (WORLD BOOK photo by Ted Nielsen)

The saxophone is a woodwind instrument made of brass. A musician plays different notes by blowing through the mouthpiece and pressing keys that open and close the tone-hole sockets.

WORLD BOOK illustration by Oxford Illustrators Limited

See also Jazz (The reeds); Mulligan, Gerry.

Sayers, Dorothy L. (1893-1957), an English author, was one of the most famous writers of detective stories of the 1900's. Her best-known works feature Lord Peter Wimsey, a sophisticated, scholarly amateur detective.

Dorothy Leigh Sayers was born in Oxford. She graduated from Oxford University. Her Wimsey stories, which reflect her background, involve well-bred characters who have graceful manners.

The most popular Wimsey novels Sayers completed are *Whose Body?* (1923), her first book; *Strong Poison* (1930); *Murder Must Advertise* (1933); *The Nine Tailors* (1934); and *Gaudy Night* (1935). A collection of all the

Wimsey short stories appeared as *Lord Peter* (1972).

In 1937, Sayers abandoned detective fiction and turned to religious works. In *Mind of the Maker* (1941), she compared God and people as creative beings. From 1949 until her death, Sayers worked on translations of Dante's *Divine Comedy.* David Geherin

Scabies, *SKAY beez,* is a contagious skin disease that causes intense itching. In adults and older children, scabies may affect any part of the body from the neck down. It most frequently involves the skin between the fingers; under the arms; and on the wrists, elbows, breasts, penis, and lower back. Babies may be infected over their entire body, including the head.

Scabies is caused by the *itch mite,* a spiderlike animal known scientifically as *Sarcoptes scabiei.* This mite can barely be seen with the unaided eye. The female digs a burrow under the skin and lays eggs there. The eggs hatch three to five days later. The young mites mature into adults in five days to two weeks. They mate on the skin surface, and the females then dig their burrows.

Scabies is spread through skin contact. Physicians treat the disease with creams or lotions that kill the mites. Yelva Liptzin Lynfield

Scalawags, *SKAL uh wagz,* were white Southerners active in the Republican Party during Reconstruction (1865-1877), the period that followed the American Civil War. The Republican Party had Northern origins and favored giving freed blacks the right to vote. Southern Democrats who opposed change in the South used the term *scalawag* to ridicule white Southern Republicans, whom they regarded as traitors to their region and race.

After the war, the federal government required the Southern States to organize new state governments and allow black men to vote. As a result, the Republicans won control of every new Southern state government.

White Southerners who supported the Republican Party were hardly the social outcasts their Democratic enemies claimed they were. Some were experienced politicians who had opposed the war. Others represented poor white farmers who wanted to reduce the power of wealthy plantation owners. Still others were business leaders who hoped Republicans would introduce manufacturing and railroads to lessen Southern dependence on agriculture.

To succeed in the South, the Republicans had to develop a large following among Southern whites. But they failed to do so, partly because of the abuse and social isolation inflicted on them. By the end of 1877, the Republicans had lost control of all the Southern state governments. Michael Perman

See also **Reconstruction.**

Scald. See **Burn.**

Scale is any one of the flat plates that form the outer covering of most fishes and many snakes and lizards. Scales overlap one another like shingles, forming a protective covering for the softer body beneath. Scales vary in size, shape, arrangement, and developmental origin, depending on the species. See **Scale insect; Butterfly** (picture: Overlapping scales); **Fish** (Scales; pictures); **Reptile** (illustration: The skin of reptiles). G. J. Kenagy

Scale, Weighing, is a device used to measure weight or mass. Scales are used in business and science to weigh loads ranging from extremely light substances, such as drugs, to railroad cars that weigh many tons. There are three main types of weighing scales. In order of their historical development, they are (1) balances, (2) mechanical scales, and (3) electronic scales.

Balances, the oldest type of scale, were first used in ancient Egypt about 2500 B.C. The two main kinds of balances are the *equal-arm balance* and the *steelyard.*

The equal-arm balance consists of a horizontal bar with a pan suspended from each end. The bar is supported at the center by a piece of metal or other hard substance, called a *pivot.* The load being weighed is placed in one pan. Weights of known quantity are placed in the other pan until the two pans balance. A pointer indicates balanced pans. Scientists use balances to weigh very light substances. See **Balance.**

The steelyard was developed by the ancient Romans about 2,000 years ago. It uses a small weight to balance a large load. The horizontal bar on a steelyard has arms of unequal length. A pan or hook on the shorter arm holds the load. A small weight called a *poise* is moved along the longer arm until it balances the load. Markings on this arm indicate the load's weight.

Mechanical scales were first developed in the 1700's. Nearly all mechanical scales have levers that reduce the force of a large load to a smaller force that is read by a sensitive weight indicator. Mechanical scales may be grouped according to the type of weight indicator used. There are three types of mechanical indicators: (1) a beam, (2) a spring, and (3) a pendulum.

Beam scales use poise to indicate the weight of the load. The poise is moved along the beam until the load is balanced. Markings on the beam give the weight. Many physicians use beam scales to weigh patients.

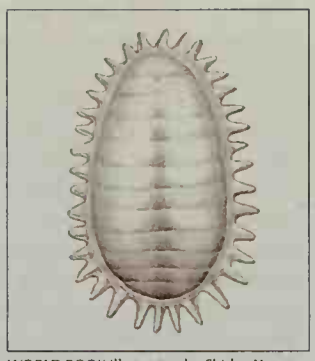
Spring scales use one or more springs to balance the load, which rests on a pan or platform. The weight of the load stretches or compresses each spring. This action causes the weight indicator to move and automatically give the weight. A bathroom scale is a common type of spring scale. Some spring scales, such as hanging produce scales, operate without levers.

Pendulum dial scales use a dial containing a weighted pendulum to indicate the weight. The pendulum swings out to one side to balance the platform containing the load. A needle hooked to the pendulum rotates on the dial to give the weight. This mechanism is used in many types of scales throughout industry. Food stores use these scales to weigh meat and produce.

Electronic scales were first introduced commercially in the 1950's. They use various electronic methods to measure and indicate weight. Most electronic scales contain a device called a *strain-gauge load cell.* This device measures the force created by the weight of the load placed on the scale. It then converts the force measurement into an electrical signal and transmits the signal to an electronic weight indicator. The weight indicator converts the signal into a weight reading.

Electronic scales can weigh loads faster and less expensively than can other kinds of scales, and they usually provide more accurate readings. Most of them also contain *microprocessors* (tiny computer chips) that enable the scales to perform activities in addition to weight measurement. Such activities may include determining the number of items in the load, calculating the price of the load, and transmitting information to printers and computers. Norman F. Meulenberg

Scale insect is one of many kinds of sucking insects that feed on plants. Scale insects cluster on plants, sucking out the juices through their tiny, tubelike beaks. They may weaken a plant so much that it dies.



WORLD BOOK illustration by Shirley Hooper, Oxford Illustrators Limited

Scale insect

The female scale insect does most of the damage. The adult male has no mouth and cannot feed. It lives long enough only to fertilize the female's eggs. Immature males feed for a short time and can do some damage. Most female scale insects are oval-shaped. They are from 0.04 to 1 inch (1 millimeter to 2.5 centimeters) long, depending on the species. The scale insect gets its name from the waxy or scaly shell that usually covers its body. Some scale insects lack eyes, feelers, and legs and rarely move.

Scientists know of more than 2,000 kinds of scale insects, over 400 of which live in the United States. The *San Jose scale,* one of the best-known and most harmful kinds, feeds on many fruit trees and shrubs. It was first found in the United States near San Jose, California, in about 1870 (see **San Jose scale**). Another scale insect that attacks fruit trees, the *cottony cushion scale,* seemed likely at one time to wipe out all the citrus trees in California (see **Insect** [Insect control]).

Some scale insects are useful. Shellac, a varnish, comes from a scale called the *lac insect* (see **Lac**). Cochineal, a dye, comes from the *cochineal scale.* One kind of scale insect is used as jewelry. This insect covers itself with shells called *ground pearls.*

Scientific classification. Scale insects are members of the order Hemiptera. Ellis W. Huddleston

See also **Whitefly.**

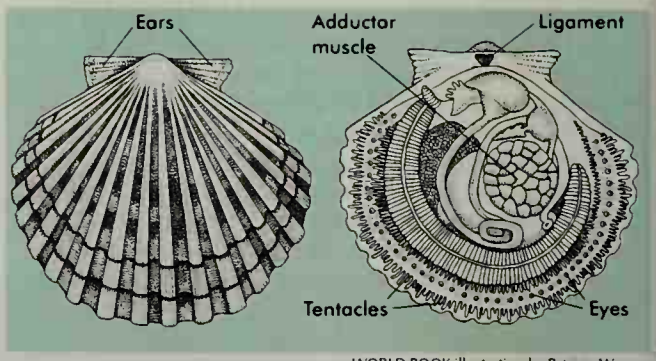
Scalia, *skuh LEE yuh,* **Antonin** (1936-), became the first American of Italian descent to serve as an associate justice of the Supreme Court of the United States. President Ronald Reagan nominated him to fill the vacancy created when Justice William H. Rehnquist became chief justice in 1986. Scalia is known for his conservative views on many issues.

Scalia was born in Trenton, New Jersey. He graduated with high honors from Georgetown University and Harvard Law School. He worked at a law firm in Cleveland in the 1960's and later taught at the University of Virginia and University of Chicago law schools. In the 1970's, Scalia held several executive branch positions, including assistant attorney general in the U.S. Department of Justice. He was a judge of the U.S. Court of Appeals for the District of Columbia Circuit from 1982 until he joined the Supreme Court. Owen M. Fiss

See also **Supreme Court of the United States** (picture).

Scallop, *SKAHL uhp* or *SKAL uhp,* is a marine animal that is a popular human food. Scallops are *bivalve mollusks* (animals with a two-pieced shell). They live in shallow waters in almost all seas and often are found in large groups.

The scallop shell consists of two equal rounded pieces called *valves,* which often have fanlike, radiating ribs. At the hinge of the shell, where the ligament unites the valves, there are two winglike projections called *ears.* The inside of the shell is lined with fleshy skin called the *mantle.* The edge of the mantle is folded and fringed with numerous *tentacles* (feelers). A row of brightly colored eyes lies at the base of the tentacles. Scallops normally keep their shells open. But in case of danger, they use large *adductor muscles* to close the shell. Some scallops can propel through the water by rapidly opening and closing their shells.



WORLD BOOK illustration by Patricia Wynne

A scallop has a hard shell, *left.* Tentacles and eyes grow along the edge of the *mantle* (skin) inside the shell, *right.*

Several species of scallops live along the Atlantic and Pacific North American coasts. An important commercial species is the common bay scallop, found in inlets from Massachusetts to the Gulf of Mexico. Another commercially harvested species is the sea scallop, which may grow to 8 inches (20 centimeters) in width. It occurs from Labrador to North Carolina and is common off Maine and Nova Scotia. Sea scallops are harvested by dragging chain bags over the ocean bottoms. The scallop's adductor muscle is the only part of the animal sold for food. Scallop shells have been used widely in designs and as utensils.

Scientific classification. Scallops are in the phylum Mollusca, class Bivalvia. The scientific name of the common bay scallop is *Argopecten irradians.* Robert S. Prezant

See also **Shell** (picture).

Scandinavia, *skan duh NAY vee uh,* is the name often given to the peninsula of Norway and Sweden. But the

WORLD BOOK map

Location of Scandinavia

term Scandinavia really refers to the countries where Scandinavian people live. This includes Denmark, Norway, and Sweden. These countries and Finland and Iceland form *Norden.* The countries of Norden are often mistakenly referred to as Scandinavia.

Fennoscandia is a term that is often used to describe Finland and the Scandinavian Peninsula. Many regions near the Baltic Sea are known as *Baltoscandia,* because their climate and customs are much like those of the Scandinavian countries. Southern Sweden is called *Skåne,* or *Scania,* an ancient Roman word for a legendary island north of the Baltic Sea. M. Donald Hancock

See also **Denmark; Norway; Sweden.**

Scandinavian literature consists of the literature of the Scandinavian countries—Denmark, Norway, and Sweden—and of Finland and Iceland. Scandinavian writers have produced outstanding works of literature for more than 1,000 years. For the social and political background of Scandinavian literature, see the articles on these countries.

Beginnings. Early Scandinavian literature developed from oral tales and poems passed down from generation to generation for several hundred years. Some poems about the lives of the upper classes in the *Viking Age* might date from the A.D. 800's (see **Vikings**).

During the 1200's, oral ballads became popular, especially in Denmark and Sweden. The ballads praised the deeds of heroes, told tragic stories, and described encounters between human beings and magical creatures. Many oral poems were collected in the Icelandic *Poetic Edda.* Most of the poems narrate mythology and the legend of a royal family called the Volsungs.

Between 1100 and 1300, lengthy stories called *sagas* were written. Sagas tell of heroic adventures and the lives of chieftains. *Njal's Saga,* by an unknown author, resembles a historical novel. It describes a violent feud between two families. Icelander Snorri Sturluson's *The Heimskringla* (early 1200's) relates the history of the Norwegian kings who reigned before the 1200's.

During the Reformation, the Bible was translated into Swedish and Danish. Latin previously had been the language of learned authors. But in the 1500's, churches encouraged hymns to be written in native languages. Hymns written by the Dane Thomas Kingo and the Norwegian Petter Dass in the 1600's are still used.

The 1700's. During the 1700's, writers became more secular and more interested in the everyday life of common people. For example, the Swedish poet Carl Michael Bellman wrote about rowdy life in the taverns of Stockholm, Sweden.

Scandinavian theater also grew in importance during the 1700's. Ludvig Holberg, Scandinavia's first major playwright, became famous for his witty comedies. Johannes Ewald, a Dane, won praise for his tragedies.

The Golden Age. Scandinavia, Finland, and Iceland produced many outstanding writers during the 1800's. Most writers of this time were influenced by two literary movements—*romanticism* in the early and mid-1800's, and *realism* in the latter third of the century. See **Romanticism; Realism.**

Many romantic writers emphasized imagination, emotion, and the glory of the Viking Age. These writers included Henrik Arnold Wergeland of Norway, Carl Jonas Love Almquist of Sweden, and Nicolai Frederik Severin Grundtvig of Denmark. Many romantics were interested in folklore. Elias Lönnrot of Finland used his country's ancient myths and legends to form the epic poem *The Kalevala* (1835). Peter Christen Asbjørnsen and Jørgen Moe, both of Norway, published Norwegian folk tales. Hans Christian Andersen of Denmark wrote fairy tales and stories that became world famous.

Other romantic writers praised rural life. In the novel *Seven Brothers* (1870), Aleksis Kivi of Finland portrayed the lives of peasants. Bjørnstjerne Bjørnson, one of Norway's greatest novelists and playwrights, wrote about country life. Jøn Thóroddsen of Iceland examined the lives of Icelandic farmers in several novels.

Realistic writers tried to describe life accurately and objectively and were often critical of society. The works of the Norwegian Henrik Ibsen and the Swede August Strindberg greatly influenced modern Western drama. In such plays as *A Doll's House* (1879) and *An Enemy of the People* (1883), Ibsen attacked the double standard of people, particularly where marriage is concerned. Strindberg also attacked social customs. In his later plays he helped develop the literary movement *expressionism* (see **Expressionism** [Expressionist drama]).

The modern period in Scandinavian literature began in the 1890's and included both realistic and romantic writings. The Norwegian Knut Hamsun wrote about people who rejected society in the novels *Hunger* (1890) and *Pan* (1894). The Dane Martin Andersen Nexø's monumental epic *Pelle the Conqueror* (1906-1910) praises the early labor movement. Selma Lagerlöf of Sweden and Sigrid Undset of Norway revived the historical novel. Lagerlöf's *Gösta Berling's Saga* (1891) relates the colorful adventures of a boastful young man and his companions.

Isak Dinesen of Denmark wrote about her years in Kenya in *Out of Africa* (1937). She composed complex, mysterious tales in such collections as *Seven Gothic Tales* (1934) and *Winter's Tales* (1942). A poor Icelandic fishing community is the subject of *Salka Valka* (1931-1932) by Halldór K. Laxness of Iceland. In the play *The Hangman* (1933) and the novel *The Dwarf* (1944), Pär Fabian Lagerkvist of Sweden describes the cruelty he saw in life.

In the late 1900's, writers who dealt with feminist issues became prominent. Among them were Sweden's Sara Lidman, Denmark's Dea Trier Mørch, Finland's Märta Tikkanen, Iceland's Svava Jacobsdóttir, and Norway's Herbjørg Wassmo. Niels Ingwersen

Related articles. See the *Arts* section of the **Denmark; Norway;** and **Sweden** articles. See also the following articles:

Andersen, Hans Christian
Asbjørnsen, Peter Christen
Bjørnson, Bjørnstjerne
Dinesen, Isak
Edda
Fafnir
Hamsun, Knut
Holberg, Ludvig
Ibsen, Henrik
Kierkegaard, Søren Aabye
Lagerkvist, Pär Fabian
Lagerlöf, Selma
Mythology (Teutonic mythology)
Saga
Skald
Snorri Sturluson
Strindberg, August
Undset, Sigrid
Wergeland, Henrik Arnold

Scandium, *skan dee uhm,* is a soft, silvery-white metal. Its chemical symbol is Sc. It has an atomic number of 21 and an atomic weight of 44.955910. In 1869, Dmitri Mendeleev of Russia predicted the existence of the element. In 1879, Lars Nilson of Sweden discovered

it in the minerals gadolinite and euxenite. He named the element *scandium* after Scandinavia. Scandium is found in tiny amounts in over 800 minerals but is costly to extract and has no significant use. Scandium melts at 1541 °C and boils at 2831 °C. It has a density of 2.989 grams per cubic centimeter at 20 °C. R. Craig Taylor

See also Element, Chemical (table).

Scanning probe microscope is any of a variety of microscopes that scan the surface of materials with a sharp point and display the results on a televisionlike screen. The point, called a *probe,* can be as tiny as 0.3 billionth of a meter (about $\frac{1}{80,000,000}$ inch) across—about the width of an atom. Scanning probe microscopes can provide three-dimensional images of individual atoms. They have become important research tools in physics, engineering, and chemistry.

The first of these microscopes was the *scanning tunneling microscope (STM),* invented in 1981 by physicists Gerd Binnig of West Germany and Heinrich Rohrer of Switzerland. Binnig and Rohrer won shares of the 1986 Nobel Prize in physics for their invention.

The STM creates an atomic map of surfaces. It works with materials that can carry an electric current. The STM brings its probe to within 1 *nanometer* (1 billionth of a meter) of the *sample* (the surface being studied) and creates a *voltage* (difference in charge) between the probe and the sample. The voltage creates a *tunneling current,* an electric current consisting of a flow of electrons between the probe and the sample.

The strength of the tunneling current depends on the distance between the probe and the sample. As the probe scans the sample, the STM measures the current and keeps it constant by raising or lowering the probe. A computer records the probe's movements and uses them to create the image. The image can be up to about 100 million times as large as the sample. One use of the STM has been to study the growth of silicon crystals, which are used as computer chips.

Another major type of scanning probe microscope is the *atomic force microscope (AFM).* The AFM does not use a tunneling current, so researchers can use it to study samples that do not conduct electricity. In most applications, the probe gently touches the sample. As the probe scans the sample, the AFM measures the mechanical force between the probe and the sample. When the force increases due to a bump on the sample, the AFM moves the probe upward. When the force decreases due to an indentation in the sample, the AFM moves the probe downward. A laser device measures the up-and-down movements. A computer uses the measurements to create the image.

Another type of AFM has a magnetic probe. The probe does not touch the sample but moves up and down in reaction to magnetic forces between itself and the sample. Researchers use this AFM with such samples as the surfaces of magnetic disks for computers.

Other scanning probe microscopes include the *scanning thermal profiler,* which reacts to temperature differences on the sample. The *scanning near field optical microscope* measures light reflected from the sample. The *scanning electrochemical microscope* reacts to chemical changes on the sample. Paul Hansma

Scapegoat, *SKAYP goht,* originally meant one of the two goats received by the Jewish high priest in ancient Jerusalem on the Day of Atonement. One was for *Yaweh* (Jehovah), the Hebrew God, and was killed as a sacrificial offering. The second was called the scapegoat. This one was for *Azazel,* which may have been the spirit of evil. The priest laid his hands upon the scapegoat as he confessed the people's sins. Then the priest sent the scapegoat into the wilderness. This was a symbol that the sins had been forgiven. Today, a person who has been blamed for something which is the fault of another is referred to as a scapegoat. The ritual is described in Leviticus 16. Gary G. Porton

Scar is a permanent mark left when an injury on the skin or other part of the body heals. Scars may result from a wound, such as a deep cut, or from a major burn, sore, or surgery. Generally, such injuries damage the *dermis* (second layer of skin), which contains connective tissue. Damage to only the *epidermis* (outermost layer of skin), such as a scratch, does not produce a scar.

When an injury heals, new connective tissue forms. Then a new epidermis covers the injured area—the scar. The scar at first is red. The redness in time fades, but the scar may remain white and hairless. The cells that contribute to skin color and hair formation die when the injury occurs. Scars become smaller as they heal and often itch or hurt.

Scars vary according to the area where they form. For example, a cut over the breastbone produces a wider, thicker scar than a similar cut on the face. Sometimes, too much connective tissue forms during healing. This condition results in an elevated scar. It may also produce a *keloid,* which is a large scar that extends beyond the damaged area. Ugly scars may be corrected by vari-

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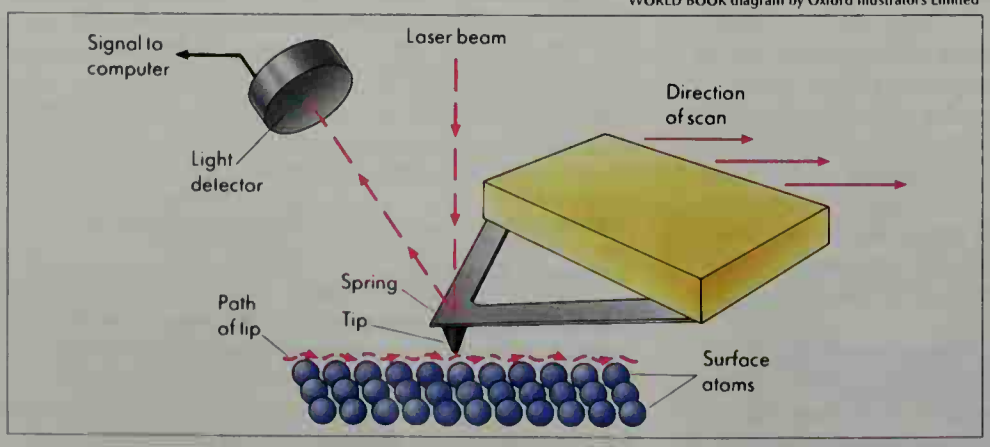

An atomic force microscope, a type of scanning probe microscope, uses a spring-mounted probe to scan surface atoms of an object. As the top of the probe moves up and down, a laser beam reflected from the spring strikes a light detector. The pattern of the reflected light provides information that a computer uses to create an image.

ous techniques that hide, flatten, smooth, or elevate the injured area. Yelva Liptzin Lynfield

Scarab, *SKAR uhb,* is the name of a large group of beetles. There are about 20,000 species of scarabs. Some of them, including Japanese beetles and Junebugs, feed on plants and may harm lawns or crops. Other species breed in *dung* (manure). They sometimes roll this dung into pellets, which they roll to their burrows to be used as larval food. Eggs are laid in the pellets.

The ancient Egyptians regarded the pellets of the *sacred scarab* as symbols of the world. They believed projections on the heads of the beetles were emblems of the rays of the sun. The sacred scarab also symbolized the resurrection and immortality. They carved figures of the insects out of stone or metal and used them as charms. Such figures were called scarabs. Usually, Egyptians removed the heart of a dead person and put a large carved and often jeweled scarab in its place during embalming. Candace Martinson

WORLD BOOK illustration by Shirley Hooper, Oxford Illustrators Limited

Scarab

Scientific classification. Scarabs belong to the order Coleoptera and make up the scarab family, Scarabaeidae. The sacred scarab is *Scarabaeus sacer.*

See also **Beetle** (Scarabs); **Japanese beetle; Junebug.**

Scarlatti, *skahr LAHT ee,* **Alessandro,** *AH lays SAHN droh* (1660-1725), was an Italian composer known primarily for his operas. He spent most of his life in Naples and often is referred to as the founder of the Neapolitan school of opera, which flourished in the 1700's.

Scarlatti composed about 85 operas. Most of these are in the *opera seria* (serious opera) style. For more information about this style, see **Opera** (Baroque opera [Opera seria and opera buffa]). Scarlatti's most popular operas during his lifetime include *Il Mitridate Eupatore* (1707) and *Il Tigrane* (1715). Scarlatti composed more than 600 *cantatas,* which are dramatic love songs for voice, harpsichord, and cello. He also wrote oratorios, church music, and some instrumental music.

Scarlatti was born in Palermo. At the age of 12, his parents sent him to Rome, where he probably began his music education. By about 1680, he had attracted the attention of several wealthy patrons. Scarlatti moved to Naples in 1684. Joscelyn Godwin

Scarlatti, *skahr LAHT ee,* **Domenico,** *doh MAY nee koh* (1685-1757), was an Italian composer. He became famous for his sonatas for an early keyboard instrument called a *harpsichord.* Scarlatti composed more than 550 harpsichord sonatas, each in a single movement. He also wrote operas and cantatas. Scarlatti greatly influenced later keyboard playing, requiring techniques such as crossing the hands, *arpeggios* (fast successions of notes in a chord), and rapid repetitions of notes.

Scarlatti was born in Naples. His father was Alessandro Scarlatti, a famous opera composer. At first, Domenico tried to follow his father's example, composing Italian operas. In 1719, he moved to Lisbon, Portugal, where he taught harpsichord to Princess Maria Barbara. In 1728, the princess married Prince Ferdinand of Spain and moved to Spain. At her request, Scarlatti followed her and spent the rest of his life in Spain. Joscelyn Godwin

Scarlet fever is an infectious disease that chiefly affects children. Its name comes from the bright red skin rash that develops during the illness. Scarlet fever was once a serious and widespread disease. Since the 1950's, the disease has become less common in many countries.

Causes. Scarlet fever is associated with bacterial infections of the throat or skin. These infections are caused by bacteria called *group A beta-hemolytic streptococci* (see **Streptococcus**). Scarlet fever results if the bacteria produce a *toxin* (poison) that affects the skin, the surface of the tongue, and the throat.

Symptoms. When scarlet fever occurs along with strep throat, the first symptoms are those of the throat infection. These include sore throat, fever, headache, and swollen lymph nodes in the neck (see **Strep throat**). The scarlet fever rash generally becomes noticeable within two days after the illness begins. It resembles red goose pimples. It may spread over most of the body except the face. The tongue becomes extremely red, a condition called *strawberry tongue.*

After several days, the skin peels, particularly on the fingers, palms, toes, and soles of the feet. The surface of the tongue also peels, leaving a rough, red surface called *raspberry tongue.* In most cases, all signs of the disease disappear within two weeks.

The first symptoms of scarlet fever associated with skin infections vary according to the type of skin disorder. In the past, many cases followed the streptococcal infection of wounds. Today, most cases are associated with chickenpox or with streptococcal impetigo (see **Chickenpox; Impetigo**). After scarlet fever symptoms begin, most cases resemble a milder version of the disease that is associated with streptococcal throat infections.

Complications. Some scarlet fever victims later develop serious complications, particularly *rheumatic fever* or a kidney disease called *acute glomerulonephritis* (see **Rheumatic fever; Nephritis**). Acute glomerulonephritis may occur following scarlet fever associated with either throat or skin infections, but rheumatic fever rarely develops after skin infections.

Treatment. Physicians generally prescribe penicillin to treat scarlet fever. This antibiotic kills the streptococci. Such treatment eliminates the danger of rheumatic fever but does not always prevent acute glomerulonephritis. Other medications can relieve such symptoms as fever, headache, itching, nausea, or vomiting. Patients with scarlet fever should stay indoors for one day after beginning penicillin treatment. This reduces the risk of spreading the disease. Russell W. Steele

See also **Disease** (table).

Scenery. See **Theater** (Scene design); **Ballet** (Sets and costumes).

Schaller, *SHAH luhr,* **George Beals** (1933-), is an American zoologist known for his writings on endangered species of animals. He has studied and photographed animals in many parts of the world. Schaller is best known for his studies of large mammals. He has observed the behavior of lions in Tanzania, mountain goril-

las in Zaire–now Congo (Kinshasa)–and Uganda, tigers in India, and giant pandas in China. He also has studied white pelicans in Wyoming, caribou in Alaska, and sea otters in California. He watches the animals daily as they hunt, eat, and care for their young.

Schaller's studies have provided valuable information on the conditions needed for the survival of endangered species. This information can be used in planning programs to protect the animals' environment.

Schaller has written many books and articles on the behavior of animals. His book *The Serengeti Lion: A Study of Predator-Prey Relations* (1972) was awarded the 1973 National Book Award for the sciences. His other books include *The Year of the Gorilla* (1964), *Stones of Silence: Journeys in the Himalaya* (1980), *The Giant Pandas of Wolong* (1985), and *The Last Panda* (1993).

Schaller was born on Nov. 26, 1933, in Berlin, Germany. He graduated from the University of Alaska in 1955 and earned a Ph.D. degree at the University of Wisconsin in 1962. In 1972, Schaller became a research associate and coordinator at the Center for Biology and Conservation of the New York Zoological Society.

G. J. Kenagy

Schechter v. United States, *SHEHK tuhr,* was a 1935 case in which the Supreme Court of the United States ruled that the National Industrial Recovery Act (NIRA) of 1933 was unconstitutional. The NIRA, a basic part of President Franklin D. Roosevelt's New Deal, empowered the president to set up codes of fair competition for businesses and industries. It was based on the federal government's constitutional power to regulate *interstate commerce* (trade between states). The Schechter Poultry Corporation of New York City was convicted of violating NIRA code. The Supreme Court found the NIRA unconstitutional because it excessively delegated legislative power to the president and to industry trade groups. The court also held that the NIRA intruded on states' powers to regulate *intrastate commerce* (trade within a state). The full name of the case is *A. L. A. Schechter Poultry Corp. et al. v. United States.* Gregg Ivers

See National Recovery Administration.

Scheherazade. See Arabian Nights.

Schelling, *SHEHL ihng,* Friedrich Wilhelm Joseph von, *FREE drihkh VIHL hehlm YOTT zehb fuhn* (1775-1854), was a German philosopher. His earlier works are generally understood as an important link between Immanuel Kant and Johann Gottlieb Fichte on the one hand, and G. W. F. Hegel on the other. These early works represent German idealism and romanticism. His *System of Transcendental Idealism* (1800) was the major work of his youth. But he later criticized his own early works and Hegel's philosophy as "negative philosophy." Schelling attempted to develop a "positive philosophy" that stressed revelation and influenced existentialism.

Schelling was born on Jan. 27, 1775, in Leonberg, near Stuttgart, Germany. He entered the Tübingen theological seminary at the age of 16, and became a friend of Hegel and the poet Friedrich Hölderlin. Hegel, in the preface to his book *Phenomenology of Spirit* (1807), criticized Schelling, though not by name, and their relation changed from collaboration to rivalry. Soon, Hegel's influence exceeded Schelling's. Schelling became a prominent opponent of Hegel's philosophy.

Karl Ameriks

Schenectady, *skuh NEHK tuh dee* (pop. 61,821), is an industrial city on the Mohawk River in eastern New York. For location, see New York (political map). The city is a major center for the manufacture of electrical products. Schenectady and nearby Albany and Troy form a metropolitan area with a population of 875,583. The city's name comes from a Mohawk Indian name meaning *the place beyond the pine plains.*

The economy of Schenectady depends chiefly on the General Electric Company, the largest manufacturer of electrical products in the United States. The company's largest manufacturing plant and its research and development center are located there (see **General Electric Company**). Schenectady factories also make cement products, chemical products, gloves, and other goods.

Schenectady's landmarks include two historic districts. One, called the Stockade, has many houses that were built in the 1600's and 1700's. The other district, the GE Realty Plot, has many fine houses built mainly for General Electric executives and scientists in the early 1900's. Union College, one of the nation's oldest private colleges, was founded in Schenectady in 1795.

Dutch pioneers bought the site of Schenectady from the Mohawk Indians in 1661. Schenectady was chartered as a borough in 1765 and as a city in 1798. General Electric began operating there in the late 1800's. Schenectady is the seat of Schenectady County and has a mayor-council form of government. Timothy N. Coakley

Scherzo, *SKEHR tsoh,* is a short, lively musical composition. The term is used to describe the third movement of a four-part symphony, sonata, or chamber music composition. Most scherzos feature a fast beat and abrupt changes in rhythm, and are humorous and playful. Scherzos also include a contrasting section called a *trio.* The trio in most cases is quieter and more melodious than the rest of the scherzo.

In the early 1800's, the German composer Ludwig van Beethoven established the scherzo as a basic part of the symphony. Famous scherzos include those in *Romeo and Juliet* (1839) by Hector Berlioz of France and *A Midsummer Night's Dream* (1843) by Felix Mendelssohn of Germany. R. M. Longyear

Schiele, *SHEE lay,* Egon, *AY gawn* (1890-1918), was an Austrian artist. He was one of the masters of expressionism in Austria during the early 1900's.

Schiele was influenced by the French Impressionists early in his career but soon turned to the work of his fellow Austrian artist Gustav Klimt for inspiration. Schiele's style displays some of the decorative qualities and curved lines common to Klimt's art. However, Schiele was more concerned with capturing the emotional states of the human figure. He occasionally painted landscapes but generally devoted himself to portraying partly clothed or nude women and self-portraits. His figures are angular, thin, and twisted into unusual and uncomfortable poses. They suggest anxiety, tension, and violence, often combined with eroticism. The public found Schiele's work disturbing in its frank depiction of sexuality, and he was once briefly jailed on a morals charge. Schiele was born on June 12, 1890, in Tulln and died in Vienna during an influenza epidemic. Pamela A. Ivinski

Schiller, *SHIHL uhr,* Johann Christoph Friedrich von, *YOH hahn KRIHS tawf FREE drihkh fuhn* (1759-1805), ranks second only to Johann Goethe among the

leading figures of German literature, and no German compares to him as a playwright. Schiller was a master of dramatic construction and character portrayal. His dramas are pleas for human freedom and dignity. They inspired German liberals in their fight for liberty during the early 1800's and during the Revolution of 1848.

Friedrich Schiller was born in Marbach in the Duchy of Württemberg. The Duke of Württemberg made him attend a military academy where he studied medicine, but he left his post as an army surgeon in 1782 to devote himself to writing. Schiller's early plays protested against the tyranny of the German aristocracy. His first drama, *The Robbers* (1781), enjoyed sensational success. His other early plays include the political-historical dramas *Fiesco* (1783) and *Don Carlos* (1787), and the middle-class tragedy *Intrigue and Love* (1784).

The period between 1787 and 1796 formed a separate part of Schiller's career. Unsure of his abilities as a dramatist, he turned to historical writing with *The Revolt of the Netherlands* (1788), a work dealing with the same period as *Don Carlos;* and *The History of the Thirty Years' War* (1791-1793). Schiller's literary talents injected a vivid dramatic quality into these works. His writings on philosophy and aesthetic theory gave him an important place in the development of German idealism. His *Aesthetic Education of Mankind* (1793) established him as the most important theorist of German classicism.

Schiller's friendship with Goethe from 1794 reawakened his interest in drama. His greatest drama, *Wallenstein* (1798-1799), is a tragedy set during the Thirty Years' War. It explores the relationship between a great individual and fate. The drama is a cycle of three parts, written in dignified blank verse. Three other historical plays followed. *Maria Stuart* (1800) deals with the life of the Scottish queen. *The Maid of Orleans* (1801) is the story of Joan of Arc. *William Tell* (1804) dramatizes Switzerland's struggle for freedom. *The Bride of Messina* (1803) is modeled on classical Greek drama.

Between 1785 and 1800, Schiller edited three literary magazines, to which he contributed many essays, lyrics, and stories. He became known for such philosophical lyrics as "The Song of the Bell." Two stories, "The Ghost-seer" and "The Criminal from Lost Honor," are early German short-story masterpieces. Klaus L. Berghahn

See also German literature (The Storm and Stress movement).

Thyssen Bornemisza Collection, Lugano, Switzerland (SCALA from Art Resource)

A Schiele portrait painted in 1916 illustrates the artist's skill at capturing the emotional states of his subjects.

Schindler, Oskar (1908-1974), was a German businessman who saved more than 1,200 Jews from almost certain death. Schindler made a fortune on military contracts during World War II (1939-1945) and spent nearly all of it to save Jews from the Holocaust, the Nazi campaign to exterminate them.

Schindler was born in Zwittau, Austria-Hungary (now Svitavy, Czech Republic). This region was home to many ethnic Germans. In the 1930's, Schindler became sales manager of an electrical engineering firm in Brno, in what was then Czechoslovakia. During business trips to Poland in 1938 and 1939, Schindler spied for the Germans. After Germany invaded Poland in 1939, Schindler moved to the Polish city of Kraków. He took over an enamelware factory there and staffed it with Jewish slave labor. By 1941, he was making huge profits supplying the German army with pots and pans.

In 1943, the Nazis moved Schindler's workers to a labor camp at Plszów, near Kraków. The camp was run by Captain Amon Goeth of the SS, the elite Nazi Party guard. To protect his workers from the hunger and violence at Płszów, Schindler built a branch camp at his factory, where most of his workers lived. When the Russian army approached in 1944, the SS planned to close Płszów and the branch camp and send the inmates to a death camp. Schindler persuaded the Nazis to let him open a new factory at Brünnlitz (now Brněnec, Czech Republic, near Svitavy). He made a list of more than 1,100 Jews whom he wanted to work at the factory. The list became famous as "Schindler's list." Schindler brought about 100 more Jews into the camp in the following months. The Jews at the Brünnlitz camp were freed by the Russian army in 1945. Charles W. Sydnor, Jr.

See also **Holocaust.**

Schipperke, *SKIHP uhr kee,* is a dog of Belgium. It is also called the *barge dog* or *little skipper,* because it once guarded canal barges and hurried the horses that pulled them. The dog has a foxlike head with small, pointed ears. It has a heavy black coat with a longer *ruff* (frill of hair) on its neck. Some schipperkes are born without a tail. In many others, the tail is *docked* (cut) to less than 1 inch (2.5 centimeters). The schipperke weighs about 15 pounds (7 kilograms). See also Dog (picture: Nonsporting dogs).

Critically reviewed by the Schipperke Club of America

Schirra, *shih RAH,* **Walter Marty, Jr.** (1923-), served as a United States astronaut from 1959 to 1969. He was one of the seven original astronauts and the first

to fly in three different types of spacecraft—Mercury, Gemini, and Apollo.

On Oct. 3, 1962, Schirra circled the earth six times in Sigma 7, a Mercury program spacecraft. He took part in the first space *rendezvous* (meeting) on Dec. 15, 1965, when he and Thomas P. Stafford guided Gemini 6 to within 1 foot (30 centimeters) of Gemini 7. Schirra was the command pilot of Gemini 6 and of Apollo 7, which was the first U.S. spacecraft to carry three men.

Schirra was born in Hackensack, New Jersey, and learned to fly airplanes as a boy. His parents were stunt fliers. Schirra graduated from the U.S. Naval Academy in 1945. He flew 90 combat missions during the Korean War (1950-1953). He retired from the astronaut program and the Navy in 1969. James R. Hansen

See also **Space Exploration** (picture: The first seven U.S. astronauts).

Schism, Great. See **Pope** (The troubles of the papacy); **Roman Catholic Church** (The Great Schism).

Schist, *shihst,* is a medium- to coarse-grained rock that can easily be split into parallel layers. Schist is a *metamorphic* rock (see **Metamorphic rock**). It forms when heat and pressure alter the shape and mineral content of solid rock far below the surface of the earth. A variety of minerals occur in schist, depending on the chemical makeup of the original rock and the amount of heat and pressure that causes the change. Minerals commonly found in schist include micas, chlorite, quartz, and feldspar. Garnet, hornblende, staurolite, and kyanite or andalusite also occur in schist.

Schist commonly has flaky or elongated minerals lined up in parallel layers, along which the rock readily breaks. This structure is known as *schistosity.* The tendency to break along parallel layers is called *rock cleavage.* Schist that contains a large amount of mica is likely to cleave. Such rock has shiny breakage surfaces because mica flakes reflect light. Maria Luisa Crawford

See also **Rock** (table: Common rocks; picture).

Schistosomiasis, *SHIHS tuh soh MY uh sihs,* is the name for a sometimes fatal disease caused by three species of parasitic worms called *schistosomes.* Schistosomiasis is widespread throughout the world and afflicts more than 200 million people in Africa, Asia, South America, and some Caribbean islands. It is also called *bilharziasis* in honor of the German physician Theodor Bilharz, who identified the disease in 1851.

The schistosomes that cause schistosomiasis have the scientific names *S. mansoni, S. japonicum,* and *S. haematobium.* (The *S.* stands for *Schistosoma.*) During part of their life cycle, they live as parasites in certain freshwater snails. Later, schistosomes swim about and may enter the skin of people who wade or swim in the waters. Eventually, the worms invade the bloodstream and settle in small veins near the bladder or intestines.

The adult male and female schistosomes live in close physical association. Eggs are passed daily into the blood vessels. Most eggs are discharged into the intestine and the bladder and are eliminated with the *feces* (solid body wastes) and urine. However, some of the eggs may find their way into other organs, such as the liver and the spleen. The infected person's reaction to these eggs may cause disease.

The first sign of schistosomiasis infection is a temporary, itchy rash where the schistosomes have entered the skin. The main symptoms of the disease develop a few weeks later and include abdominal pain, coughing, discomfort, fever, nausea, and rash. Many patients experience diarrhea and weight loss. Severe cases damage the liver, spleen, and intestines. Doctors treat schistosomiasis with the drug praziquantel. Governments and health authorities try to prevent the disease by improving sanitation methods and by removing the snails from bodies of waters. Felipe Kierszenbaum

See also **Flatworm; Fluke; Aswan High Dam.**

Schizophrenia, *SKIHT suh FREE nee uh,* is a severe mental disease characterized by unpredictable disturbances in thinking. The word *schizophrenia* means *a splitting of the mind.* It refers to the characteristic schizophrenic behavior of withdrawing from reality and thinking in illogical, confused patterns. The term does not mean that a victim has more than one personality.

Schizophrenia is one of the most common mental disorders. Most patients develop the disease from their late teens to mid-20's. Men tend to develop it earlier than women and often more severely.

Many people with schizophrenia develop delusions and behave as though they live in a fantasy world. They may hear "voices" that others cannot hear. The patients may believe that these "voices" carry messages from important people, or even from God. Schizophrenics often suffer disturbances in mood and behavior. Some patients seem to feel no emotions, but others may display inappropriate emotions, such as laughing at sad situations. Some patients withdraw from their family and friends and talk mainly to themselves or to their "voices."

Physicians do not know the cause of schizophrenia. Genetic factors may be partly responsible for some cases. Abnormal brain chemistry also plays a role. Chemicals called *neurotransmitters,* which allow nerve cells to communicate with each other, have been found at abnormal levels in some people with schizophrenia.

Before the 1950's, most people suffering from schizophrenia had to remain in mental hospitals. Since then, scientists have developed drugs that block the action of *dopamine,* a neurotransmitter, on certain nerve cells. In most cases, these drugs do not cure schizophrenia, but they usually reduce the symptoms so that most patients can leave the hospital. Psychotherapy and rehabilitation programs can help patients live outside the hospital. In the United States, the National Alliance for the Mentally Ill offers support for families and patients. A small number of patients do not respond to treatment and must remain hospitalized. E. Fuller Torrey

See also **Dopamine; Mental illness** (Schizophrenia).

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Schlafly, *SHLAHF lee,* Phyllis Stewart (1924-), is a leading supporter of the traditional role of women as mothers and homemakers. She gained national attention in the United States when she helped defeat the proposed Equal Rights Amendment (ERA) to the nation's Constitution. The ERA called for men and women to be treated equally by law. Schlafly believed the amendment

would deprive women of such legal benefits as their right to get financial support from their husbands and their exemption from combat duty in the armed forces. The ERA won congressional approval in 1972. But it never took effect because it did not win approval from the required number of states by a 1982 deadline.

Wide World

Phyllis Schlafly

In 1972, Schlafly founded and became national chairman of Stop ERA, an organization that worked to defeat the ERA. In 1975, she founded another organization, Eagle Forum, which supports the preservation of traditional morality and the traditional American family. Schlafly is the author of *A Choice Not An Echo* (1964) and *Pornography's Victims* (1987). She publishes a newsletter, *The Phyllis Schlafly Report.* Schlafly received an M.A. degree from Harvard University and a law degree from Washington University. She was born in St. Louis, Missouri. Rosemarie C. Gulley

See also Equal Rights Amendment.

Schlesinger, *SHLEHS uhn juhr* or *SHLAY zihng ur,* **Arthur Meier, Jr.** (1917-), is an American historian. In 1946, he won the Pulitzer Prize for history for *The Age of Jackson.* His *A Thousand Days: John F. Kennedy in the White House* won the 1966 Pulitzer Prize for biography and the 1966 National Book Award for history and biography. Schlesinger won the 1979 National Book Award for biography and autobiography for *Robert Kennedy and His Times* (1978). He also wrote *The Age of Roosevelt* (1957, 1959, 1960), a three-volume biography of Franklin D. Roosevelt.

Schlesinger was born in Columbus, Ohio. He taught at Harvard University from 1947 to 1961. From 1961 to 1964, he was a special assistant to Presidents John F. Kennedy and Lyndon B. Johnson. Schlesinger taught at City University of New York from 1966 to 1994. His father, Arthur M. Schlesinger, was also a noted historian.

Robert C. Sims

Schliemann, *SHLEE mahn,* **Heinrich,** *HYN rihkh* (1822-1890), was a German archaeologist who founded the study of ancient Greece and neighboring cultures on the Aegean Sea. He and his wife, Sophia Engastromenos Schliemann, conducted the first major excavation of the buried city of Troy in what is now Turkey. This city was made famous in the Greek epic the *Iliad.*

Guided by the *Iliad,* the Schliemanns started to excavate Troy in 1870. Nine cities had been built on the site. Each successive city stood on the ruins of the one before it. Near the bottom level, the Schliemanns found precious objects of bronze, gold, and silver in the city they believed was the Troy of the *Iliad.* Today, most scholars think the Iliad's Troy was the seventh city from the bottom. The Schliemanns also explored Mycenae, an ancient Greek city. There, in 1876, they unearthed five royal graves full of jewels and other treasures.

Schliemann was born in Neubukow, near Wismar. He earned a fortune as a businessman in Russia during the Crimean War (1853-1856). At the age of 41, he quit business. He spent most of the rest of his life studying ancient cultures. Igor Kopytoff

See also Aegean civilization; Mycenae; Troy.

Schmalkaldic League, *shmahl KAHL dihk,* was an alliance formed by German Protestant states of the Holy Roman Empire to defend themselves against Emperor Charles V and the empire's Roman Catholic states. The league was formed in 1531, and the War of the Schmalkaldic League followed. The Protestants were defeated in 1547. However, the league's aims were partly realized five years later in a treaty called the Peace of Passau. Charles V agreed to a temporary peace until a conference could settle matters. The conference, known as the Peace of Augsburg, took place in 1555. Under its terms, Lutheran churches were legally permitted for the first time in the Holy Roman Empire. Phillip N. Bebb

Schmidt, *shmiht,* **Helmut,** *HEHL moot* (1918-), served as chancellor of West Germany from 1974 to 1982. In 1974, the country's Bundestag, the lower house of parliament, elected Schmidt to succeed Willy Brandt, who had resigned. Both men belonged to the Social Democratic Party. In 1982, the Bundestag voted to remove Schmidt from office and replace him with Helmut Kohl of the opposition party, the Christian Democratic Union. After leaving office, Schmidt became copublisher and editorial writer for the weekly publication *Die Ziet.*

As chancellor, Schmidt was known for his skillful management of economic affairs. Schmidt promoted economic cooperation among Western European nations.

Helmut Heinrich Waldemar Schmidt was born in Hamburg, Germany. He graduated from the University of Hamburg in 1949. Schmidt served in the Bundestag from 1953 to 1962 and again in 1965. He held several posts in Brandt's cabinet, including minister of economics.

Melvin Croan

Schmitt, *shmiht,* **Harrison Hagan,** *HAH guhn* (1935-), was the first United States scientist-astronaut to fly in space. In December 1972, during the Apollo 17 mission, he and astronaut Eugene A. Cernan made the longest lunar visit—75 hours on the moon. Schmitt, a geologist, examined the moon's surface and selected rocks for later study. He represented New Mexico as a Republican in the U.S. Senate from 1977 to 1983.

Schmitt was born in Santa Rita, New Mexico. He received a Ph.D in geology from Harvard University in 1964. Schmitt was an astronaut from 1964 to 1975.

Lillian D. Kozloski

Schnauzer. See Giant schnauzer; Miniature schnauzer; Standard schnauzer.

Schnitzler, *SHNIHTS luhr,* **Arthur** (1862-1931), was an Austrian writer whose works reflect the influence of Sigmund Freud's psychoanalytical ideas. Schnitzler was born in Vienna. His plays and stories deal with the decline in morality, especially sexual morality, that he saw in middle-class and aristocratic Viennese society around 1900. Schnitzler was fond of the Viennese. However, he exposed their weaknesses and shortcomings through subtle psychological probing, thereby displaying his mastery of characterization.

Schnitzler's two main themes are love and the nature of reality. Both appear in his play *Anatol* (1893), about a young man's adventures in love. The themes also appear in *Reigen,* also called *La Ronde* (published 1900, first performed 1912). This play is an intricate cycle of love af-

fairs involving different classes of society. Schnitzler's best-known work of fiction is the short novel *Leutnant Gustl* (1901). Walther L. Hahn

Schoenberg, *SHURN burg,* **Arnold** (1874-1951), was perhaps the most influential composer of the 1900's. Schoenberg's name is also spelled *Schönberg.* In 1908, Schoenberg began to write music that was *atonal*—that is, lacking in key. Use of atonality eventually led to his formulation of the *12-tone* system. In his 12-tone pieces, the melodic and harmonic material of a piece is based on a specific ordering of the 12 notes of the chromatic scale, called a 12-tone row or set. This way of composing is called *serialism.* Although highly organized, serialism presented serious challenges to audiences who found the style chaotic and confusing.

Schoenberg first used atonality in parts of his String Quartet No. 2 of 1908 and all of the Three Piano Pieces (1909). His first work to use the 12-tone system throughout was Suite for Piano (1921-1923). Later and more sophisticated uses of this method include Variations for Orchestra (1928), Violin Concerto (1936), and String Quartet No. 4 (1937). In spite of his revolutionary method of composition, Schoenberg continued to write in such classical forms as sonata, song, and rondo.

Schoenberg was born in Vienna on Sept. 13, 1874. He began writing in the late romantic tradition of such composers as Johannes Brahms, Richard Wagner, and Gustav Mahler. His early works include Five Pieces for Orchestra (1909, revised 1949), the expressionist operas *Erwartung* (1909) and *Die glückliche Hand* (1913); and *Pierrot Lunaire* (1912), a group of pieces for voice and chamber ensemble. He moved to the United States in 1933 to escape the Nazis in Germany. He taught at the University of California, Los Angeles. Stewart L. Ross

See also **Classical music** (The 1900's); **Opera** (The search for new forms).

Scholarship is a grant of money or free tuition awarded to a student on the basis of achievement, ability, or financial need. People usually consider a scholarship an honor in recognition of outstanding academic work, as well as financial aid to those who need it. Scholarships are generally awarded as a means of selecting and training capable people so that they may become assets to the community and nation.

Endowed foundations and government agencies often grant funds for advanced study and for research. Such grants are called *fellowships.* Most scholarships are awarded by universities and colleges, businesses, industries, labor unions, and government sources. See **Fellowship**; **Foundations** (Education).

The United States government provides billions of dollars in scholarship aid each year. It offers Pell Grants and Supplemental Educational Opportunity Grants based on financial need. The U.S. government also provides loans for education, as well as fellowships in selected fields of advanced study.

Private colleges and universities establish scholarships to attract students of outstanding intellectual ability and from diverse backgrounds. Scholarships also help promote particular fields of study, such as engineering or nursing. Many scholarships are founded for personal reasons and carry the name of the donor. Some of these scholarships are funded by alumni of the institution or by prominent citizens in the community.

State colleges and universities typically grant fewer scholarships than private institutions. However, state scholarships constitute a growing share of total scholarship funds available to U.S. students. Many state programs offer scholarships to state high school graduates who achieve a certain grade point average or who graduate at the top of their class. Many states set aside funds for need-based scholarships.

Merit scholarships for students with exceptional ability have been awarded annually since 1956 by the National Merit Scholarship Corporation (NMSC) of Evanston, Illinois. NMSC is a not-for-profit, independently financed organization.

The Merit Program is NMSC's major activity and is supported by grants from corporations, private foundations, colleges and universities, and other organizations. Students enter the annual Merit Program by taking the Preliminary Scholastic Assessment Test/National Merit Scholarship Qualifying Test (PSAT/NMSQT), usually during their junior year in high school. Scholarships are awarded on the basis of test scores, academic and extracurricular accomplishments, and other information submitted by the candidates and their schools.

Private-sector scholarships are awarded by such entities as corporations, foundations, trusts, and religious groups. Students may be required to show financial need or academic achievement to qualify for these scholarships. However, some recipients may just need to promise to work for the donor organization after completing their studies. Many organization scholarships are reserved for members or their children. Many others also have no age requirement and are awarded to students over the age of 25.

Grants to veterans. Federal grants were given to veterans of World War II for study in any approved college, university, or vocational or trade school. To be eligible, veterans must have had at least 90 days of service and an honorable discharge. Similar grants were made to veterans who served in the Korean War and to all veterans who served after Jan. 31, 1955, and before Jan. 1, 1977, including Vietnam War veterans.

Veterans who have begun active duty after Dec. 31, 1976, receive grant money for education if they have had a certain amount withheld from their pay. The sum that each veteran receives is significantly larger than the amount withheld. See **Veterans Affairs, Department of** (Benefits and other services).

International scholarships. Organizations in the United States and in many other countries award scholarships to allow foreign students to study in the United States. Such organizations also award scholarships to send U.S. students and teachers overseas. The purpose of these scholarships is to promote better international understanding and cultural relations.

The oldest and most famous of the international scholarships are the *Rhodes Scholarships* (see **Rhodes Scholarship**). The most numerous are the *Fulbright Scholarships,* supported by the U.S. federal government (see **Fulbright Scholarship**). They provide a year's schooling in the United States for students from other countries, and a year of study abroad for U.S. students and teachers. The U.S. clearinghouse for exchange scholarships and fellowships is the Institute of International Education in New York City. The International Research and Ex-

changes Board (IREX), based in Washington, D.C., also offers exchange opportunities.

Scholarship programs for students to study in their native country vary throughout the world. In countries where governments provide tuition-free education, few scholarship programs exist. In other countries, many universities offer scholarships and grants based on financial need. The European Union, through its Socrates/Erasmus program, offers scholarships for students to study in European countries.

Applying for scholarships. Here are some tips for people applying for scholarships: (1) consult one or more of the commercially available guidebooks for scholarship funds; (2) consult Web sites of organizations that offer scholarship search assistance; (3) consult Web sites of individual colleges and universities; and (4) apply for multiple scholarships. Anthony W. Morgan

See also **AFS Intercultural Programs.**

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Scholasticism, *skuh LAS tuh sihz uhm,* was a philosophical system that emphasized the use of reason in exploring questions of philosophy and theology. The scholastics particularly tried to prove the truth of Christian doctrine. They also tried to reconcile contradictory viewpoints in Christian theology.

Scholasticism had its greatest influence from the 1000's to the 1400's, especially during the 1200's. Most scholastics taught in the schools and universities of western Europe.

The scholastic method. The scholastics developed an extremely formal and sophisticated procedure of investigating philosophical and theological questions. The method they developed became known as the *disputed question.* The disputed question started with a problem stated by the teacher. The students then listed the arguments for and against a certain solution to the problem. Next, the students took a position on the problem. Finally, they dealt, one by one, with the arguments on all sides of the problem. Using this method, the teacher and students tried to reach a balanced solution.

Scholastics analyzed philosophical and theological questions in books called *books of sentences.* A book of sentences contained quotations or summaries of dogma compiled from the Bible, from works by early Christian writers, and—less often—from the works of other medieval writers. If the quotations or summaries conflicted, the compiler tried to reconcile the conflicts by his own commentaries based on reason. The *Four Books of Sentences* (mid-1100's) by Peter Lombard became the standard theological textbook.

Scholasticism trained its followers to consider every side of a question logically and rationally. It also trained them to state their arguments briefly and clearly. However, critics claimed that scholasticism relied so much on formal systems that it became artificial and inflexible. Critics also complained that the scholastic method led to the assumption that every problem could be solved by reasoning.

History. Scholasticism originated during the 1000's in schools operated by cathedrals and monasteries. The writings on logic by the ancient Greek philosopher Aristotle had an important early influence on scholasticism. Aristotle had used logic to try to prove the existence of God. His approach attracted many scholastics, especially Peter Abelard.

Scholasticism reached its high point during the 1200's in western European universities. Many works by Aristotle that had been unknown to medieval philosophers were translated into Latin. For the first time, scholars could study a complete body of philosophy based on experience and reason alone. Until the translations of Aristotle's works, medieval philosophy had been based largely on the Bible and on writings by early Christian theologians. The scholastics tried to reconcile Aristotle's philosophy with Christianity. They also applied his philosophy to theological problems.

The major scholastics of the 1200's included Saint Albertus Magnus, Alexander of Hales, Saint Thomas Aquinas, Roger Bacon, Saint Bonaventure, and Robert Grosseteste. Aquinas, the most important scholastic, developed a philosophy that claimed to lead through reason alone to basic truths about God and the soul. But Aquinas believed that human beings need divine revelation to fill out and expand such knowledge.

In the 1300's, the scholastics John Duns Scotus and William of Ockham rejected Aquinas's emphasis on reason. They believed that God's actions and purposes are unpredictable and must be learned through revelation.

Protestant universities also adopted many scholastic methods. But in the 1600's, scholasticism gradually lost its influence in many universities. Some of its features were revived by Pope Leo XIII in 1879. Many modern Roman Catholic thinkers reflect the influence of scholasticism. Eugene TeSelle

Related articles in *World Book* include:

Abelard, Peter
Albertus Magnus, Saint
Anselm, Saint
Aquinas, Saint Thomas
Aristotle
Bacon, Roger
Bonaventure, Saint
Duns Scotus, John
Lombard, Peter
Maritain, Jacques
William of Ockham

Schönberg, Arnold. See Schoenberg, Arnold.

Schongauer, *SHOHN gow uhr,* **Martin** (1450?-1491), was one of the first German painters to work extensively as an engraver. He became the most skillful engraver in Europe during the 1470's and 1480's. His work greatly influenced younger artists, most notably Albrecht Dürer, and he was widely copied in many countries.

Schongauer's 115 known engravings have a delicate, graceful quality and a sense of depth not seen in the work of earlier printmakers. Most of his engravings and all of his paintings have religious themes. Schongauer's most famous paintings are the *Virgin in the Rose Arbor* (1473) and the large mural *Last Judgment* (about 1491) in Breisach. His best-known engravings include *The Death of the Virgin Mary* and *Christ Bearing the Cross.* Schongauer was born and worked in Colmar, Alsace (now in France). Jane Campbell Hutchison

Jan Lönn from Carl Östman

Preschool class in North Korea

WORLD BOOK photo

Elementary school classroom in Canada

J. Alex Langley, DPI

High school chemistry lab in Mexico

Photophile

University of California at Los Angeles

The great variety of schools throughout the world is shown by the photographs above. All schools have the job of teaching people the skills needed in everyday life.

School

School is one of our most important institutions. Schools teach reading, writing, the use of mathematics, and other basic skills needed in everyday life. Schools increase people's knowledge of the world and themselves and help them understand the rapid changes that take place in modern society. Schools prepare people for jobs and careers and help them develop interests that make their leisure time more rewarding. In schools, students learn their responsibilities and rights as citizens, improve their ability to think critically, and develop such basic values as truth, justice, and equality. Human knowledge is extended through research carried out in schools.

People throughout the world attend school. But the quality of schools varies widely among countries. The industrialized nations—such as Australia, Canada, Japan, the United States, and most European nations—have well-developed educational systems. These countries provide substantial financial support for their schools. Most of the schools have skilled teachers, modern equipment, and a variety of educational materials. Most young people in industrialized countries complete elementary school and enter secondary school. Many also continue on to college.

Other nations—especially many of the developing nations of Africa and Asia—have made progress in building elementary and secondary school systems. But these nations cannot yet afford to provide long-term, quality education for most of their young people. Many children do not finish elementary school, and few people enter college. The percentage of people who can read and write well is much lower in these countries than in the industrialized nations.

From ancient times until the 1800's, most people—even in advanced societies—never attended school. In ancient Greece, for example, only the children of citizens could attend school. A majority of people in ancient Greece were not citizens. During the Middle Ages, which lasted from about A.D. 400 to the 1500's, most schools in Europe were run by the Roman Catholic Church. These schools chiefly trained young men to be priests or government officials.

Widespread development of public schools began in the early 1800's, when government leaders in many countries acted on the belief that a nation's progress depends on educated citizens. By the mid-1800's, the United States, Canada, and many European countries had established public school systems.

This article discusses schools in the United States and Canada. For information on schools in other countries

Jack L. Nelson, the contributor of this article, is Professor of Education at Rutgers The State University of New Jersey.

and education in general, see Education. See also the *People* section of articles on states and provinces and the *Education* section of various country articles.

Kinds of schools

The chief kinds of schools in the United States and Canada are (1) nursery schools, (2) kindergartens, (3) elementary schools, (4) middle schools, (5) junior high schools, (6) high schools, (7) community colleges, and (8) colleges and universities.

Nursery schools, sometimes called *preschools,* are designed mainly for children 3 and 4 years old. Most of these schools use play activities and informal methods of instruction to help prepare youngsters for kindergarten or elementary school. The schools help children learn how to work and play together. They also teach youngsters skills they will need later in school. Some *day-care,* or *child-care, centers* resemble nursery schools. However, a number of day-care centers only provide care for children and do not offer planned educational programs.

The United States and Canada have many nursery schools, and the demand for them rises every year. Many nursery schools are privately controlled, and many are very small. See Nursery school.

Kindergartens teach children during the year before they begin their elementary education. Like nursery schools, kindergartens are sometimes called *preschools.* Some states require all elementary school districts to have kindergartens, which are considered part of elementary education in these states. Most kindergarten children are 5 or 6 years old. Some of them enter kindergarten after nursery school. However, for many other youngsters, kindergarten is their first school experience.

Most kindergartens continue the informal methods used in nursery school. Some also give children formal preparation for reading, writing, and other subjects. Most kindergartens are in public elementary schools, and the majority of school systems in the United States and Canada have kindergartens. See Kindergarten.

Elementary schools provide formal education in such basic subjects as arithmetic; science; social studies; and communication skills, including reading, writing, spelling, and speaking. Most elementary schools have six or eight grades and teach children from age 6 to age 12 or 14. This type of school, in which students of about the same age are all in the same grade, is also called a *grade school* or *grammar school.*

Some communities have *nongraded,* or *ungraded,* elementary schools. Students in these schools are not grouped in grades according to age. Instead, each child advances in each subject at his or her own rate. Children attend classes with other youngsters who have advanced to the same level. Pupils transfer to a higher-level school when they reach the required age, provided that their progress is satisfactory.

The United States has about 76,000 elementary schools, of which about 60,000 are public. In addition, the country has about 10,700 elementary schools that are combined with schools of higher grade levels. About 2,700 of these schools are public. Canada totals its elementary and high schools together. It has about 16,000 such schools. See Elementary school.

Middle schools. Some U.S. communities have elementary schools that end with grade 4 or 5 rather than grade 6 or 8. In these communities, students enter a three- or four-year middle school after elementary school. Most middle schools offer the same kinds of programs offered in upper elementary school. But middle schools separate students from younger children to help prepare them for attending high school with older students. The United States has about 9,600 middle schools. See Middle school.

Junior high schools offer two or three years of education after six years of elementary school. Junior high schools, like middle schools, continue the type of general education begun in elementary school. But unlike middle schools, they introduce students to the kind of class schedule and assignments they will find in high school. The United States has about 4,000 public junior high schools. There are relatively few junior high schools in Canada. See Junior high school.

High schools in the United States provide from three to six years of education, depending on the organization of a community's school system. Systems with a three-year junior high school have a three-year *senior high school.* If the junior high school provides two years of education, the senior high school provides four years. Systems with a middle school or an eight-year elementary school have a four-year high school. Some communities have seven-year elementary schools and five-year high schools, and others have six-year elementary schools and six-year high schools. Most Canadian high schools offer a four- or five-year program. High schools are also called *secondary schools.*

Most high schools provide both *college preparatory* and *vocational* programs. A college preparatory program consists mainly of such subjects as history, language, mathematics, and the physical and social sciences. Vocational programs provide training mainly in various job skills for students who do not plan to enter college. Some schools offer either a college preparatory

WORLD BOOK photo

Community schools serve the community in general as well as its children. Many community schools offer handicraft and other courses for adults, *above,* besides the regular school program.

program or a vocational program, not both.

The United States has about 16,100 public high schools. They consist of about 11,900 three- or four-year schools; 3,600 five- or six-year schools; and 600 other schools, including vocational or technical schools. There are also about 2,600 private high schools. Private secondary schools that prepare students for college are called *preparatory schools.* See **High school.**

Community colleges, also called *junior colleges,* provide from one to three years of study after high school, though most have a two-year program. They offer two kinds of educational programs. One program consists of courses much like those taken during the first two years at a four-year college. It prepares students for further study at a college or university. The other type of program offers specialized job training.

The United States has about 1,500 community colleges, of which about two-thirds are public. Canada has about 200 community colleges, most of which are also public. The U.S. schools grant an associate's degree for completion of the program leading to further study at a college or university. The Canadian schools do not grant degrees. See **Community college.**

Colleges and universities offer advanced study after high school or junior college in a variety of fields. Most colleges have four-year programs leading to a bachelor's degree in the arts or sciences. Many also offer programs of study leading to a master's or doctor's degree.

Most universities consist of a number of colleges and schools. For example, a university may include colleges or schools of business administration, dentistry, education, engineering, law, and medicine, as well as a college of arts and sciences. Depending on the course of study they offer, the various colleges and schools award bachelor's, master's, or doctor's degrees.

The United States has about 600 public and about 1,600 private colleges and universities. Canada has about 80 degree-granting institutions, most of which are public. See **Universities and colleges.**

Other kinds of schools. Many schools in the United States and Canada provide special types of education. Some of these schools are designed for disabled or gifted children. Others provide vocational courses for adults. If such a school is owned by a private group or business firm, and operates for a profit, it is called a *proprietary school.* Correspondence schools, many of which are proprietary schools, offer home-study courses through the mail. Night schools provide courses for people who work during the day. See **Correspondence school; Special education; Vocational education.**

Some parents teach their children at home instead of sending them to a regular school. This arrangement is called *home schooling.* However, the children must receive an education equal to that of public school students. A state or province may test children educated at home to see that they meet standards for students who attend public schools.

How schools operate

A large majority of schools in the United States and Canada are publicly controlled and financed. Authority over these schools rests mainly with the states in the United States and with the provinces and territories in Canada. But local school districts have direct responsibility for operating the schools. The only exception is Hawaii, where the state operates as a single district and directly controls all public schools.

This section chiefly describes how public schools operate in local districts of the United States and Canada. For information about federal, state, and provincial authority over these schools, see **Education** (Education in the United States; Education in Canada). For information about the role of the teacher in school, see **Teaching.**

Public school districts are set up by state governments in the United States and by provincial and territorial governments in Canada. Some large districts cover an entire city. Small districts may consist of a small town or a thinly populated rural area. The United States has about 15,000 public school districts, and Canada has about 900.

Some public school districts in the United States and Canada provide only elementary schooling or secondary schooling, not both. But most districts provide both elementary and secondary schools. A district may use any of the plans of school organization described in the section *Kinds of schools.* In many areas of the United States, two or more small rural districts have been combined to form a *consolidated,* or *unified, school* (see **Consolidated school**). Many smaller Canadian districts have also been combined to form larger districts.

Each school district in the United States has a board of education, or school board, responsible for public education in the district. In addition, most districts have a superintendent of schools, appointed by the board, who supervises school operation. Most districts in Canada also have a school board and superintendent. But many smaller districts are run as part of larger, regional districts. School board members in both the United States and Canada are either elected by the people of the district or appointed by the local government.

A district's board of education sets general policies for the operation of the district. These policies deal with such matters as the hiring of school staff, the approval of courses of study, and the maintenance of school buildings and grounds. The superintendent recommends

WORLD BOOK photo

A school board is elected or appointed to run the public schools in a local school district. These boards, like the one above, decide school policy, finances, and other matters.

operating policies to the board and makes sure that district schools carry out the board's policies. In most districts, the superintendent recommends people for employment as school principals and supervises the principals' work. Each principal directs the daily operation of a school. Most teachers and other school staff are hired on the recommendation of the school principal and the superintendent.

Public school operation. Most public schools operate according to an annual district calendar, which sets the beginning and ending dates of school terms and identifies school holidays. In the United States, the typical school holds classes on weekdays, from about 8:00 a.m. to 3:00 p.m., and its classes meet from late August or early September until early June. The typical Canadian school holds classes on weekdays from about 9:00 a.m. until 4:00 p.m., and its classes meet from late August or early September until late June.

Most schools place students of similar ages in the same grade. In the lower elementary grades, a group of students may spend most of the day in one classroom with a single teacher. This teacher instructs the group in basic subjects. The students may go to other teachers for specialized instruction in such areas as physical education and the arts. In many schools, students in grades 4 through 8 are taught each subject by a teacher who specializes in that subject. Most secondary schools divide their teaching staff into departments and have one department for each subject. Students in these schools attend classes in various rooms, and each student follows an individualized course schedule.

The *curriculum* (program of learning activities) in most schools is prepared by teachers and school administrators. In most states, some teachers serve on statewide or district committees that select textbooks and other educational materials. Teachers conduct classroom activities, evaluate students, keep class records, maintain classroom order, and recommend students for awards or punishments. Principals supervise and help teachers in performing these duties. In departmentalized schools, each department includes an experienced teacher who serves as department head. The department head directs curriculum planning and teacher development within the department.

Schools hire specialists and other employees in addition to classroom teachers. The specialists may include librarians, reading specialists, and instructors who work with handicapped or gifted children. Many schools have guidance counselors, who help students select courses, choose careers, and deal with personal or family problems. Other employees include cafeteria workers, coaches, custodians, nurses, and secretaries.

Schools offer students a variety of things to do outside the classroom. These *extracurricular activities* may involve athletics, community service, dancing, music, work on school newspapers and yearbooks, and participation in student government, clubs, and honor societies. Most of these activities are school-sponsored.

Operating a school requires a great deal of money. In many communities, financing schools is the largest public expense. Most principals consult with staff members about their school's needs and then submit a list of these needs to the district superintendent. Next, the superintendent prepares a yearly budget of estimated costs for school board approval. These costs include the salaries of teachers and other staff and money for building maintenance, athletics programs, and books and supplies. The principal manages the use of funds approved for his or her school. The different sources of money for schools are discussed later in this section.

Private school operation. Private schools in the United States and Canada are operated by religious groups and other private organizations. The controlling organization appoints various administrators, who have about the same responsibilities as public school principals and superintendents. These administrators operate according to policies set by the private organization rather than by a public school board. But private schools must meet certain government standards regarding the quality of the education they offer.

Some private schools operate for a profit. But most, such as those run by religious groups, are nonprofit organizations. Private schools operated by religious groups are also called *parochial schools*. The term applies especially to elementary and high schools. For more information about parochial and other private schools, see **Private school; Parochial school.**

Financial support for the day-to-day operation of public schools in the United States and Canada comes almost entirely from taxes. Major long-range projects, such as the construction of a school building, are often financed by bond issues. School bonds require approval of the voters in the school district. The bonds are repaid from public tax receipts over a long period of time.

In the United States, the states provide nearly half of the tax money needed for public school operations. The local school districts provide about 43 percent, the federal government provides about 7 percent, and about 2 percent comes from private sources. In Canada, the provinces and territories provide about 54 percent of public school costs, local communities about 21 percent, and the federal government about 11 percent. About 14 percent comes from fees and other sources of funding.

Private schools in the United States receive almost all their financial support from private sources, such as tuitions, gifts, and church donations. Quebec and several other Canadian provinces help support Roman Catholic and Protestant schools with tax money. But in some Canadian provinces, private schools receive little or no government assistance.

For more information about the financial support of U.S. schools, see **Education** (Financial support; How should education be financed?).

History of U.S. schools

Colonial schools. The first schools in what is now the United States were established in the early 1600's by colonists from Europe. The colonists set up private schools to teach reading, writing, and religion. In 1636, the Massachusetts Bay Colony founded Harvard College, the first institution of higher learning in the American Colonies.

In 1647, Massachusetts passed the first law in the colonies to require the establishment of public schools. The law required every town with at least 50 families to start an elementary school for all children. In addition, every town with 100 families or more had to set up a

Latin grammar school. These secondary schools emphasized instruction in Latin and were designed chiefly to prepare boys for college.

In the 1700's, private secondary schools called *academies* opened in many colonies. They taught bookkeeping, navigation, and other practical subjects in addition to such subjects as English and Latin. Some academies admitted girls, and some were established for girls only.

Colonial school buildings were simple log or wood-frame structures. Most consisted of a single room with a stove in the middle and a few windows. They had benches or crude wooden desks for the students.

The first school districts were established in New England during the mid-1700's. But the district system did not become widespread until the 1800's.

The growth of the public school system. The demand for public education increased in the United States during the early 1800's. American political leaders, like those in Europe, saw that a nation's economic and social well-being depended on educated citizens. Labor unions in the growing cities also demanded schools for the children of laborers. In response, state legislatures gave communities authority to collect property taxes to pay for schools. The states themselves also began to give financial aid to school districts.

In 1837, Massachusetts appointed the nation's first state board of education and the first state secretary of education. Horace Mann, one of the greatest champions of U.S. public education, was the first secretary. The board's job was to set school policy. The secretary's job was to supervise the formation and operation of school districts. Soon, many other states also established a board of education and appointed a state official to administer the school system.

After 1850, states began to pass *compulsory* school-attendance laws. These laws required children to attend school until they completed a certain grade or reached a certain age. Today, every state has such a law.

The New Canaan Historical Society, Connecticut

The one-room school was common in U.S. rural areas during the 1800's. Most had one teacher, who taught all grades. This picture shows such a school in New Canaan, Conn., in the 1890's.

The expanding role of public schools. During the 1800's, new kinds of public schools were started. For example, Boston started the nation's first public high school in 1821. In 1851, Massachusetts established the first public school for mentally retarded children. The first public kindergarten in the United States opened in St. Louis in 1873. Also during the 1800's, public schools began to offer new courses of instruction. For example, they started physical education classes in the mid-1800's and *manual training* classes in the industrial arts in the 1880's. Homemaking classes for girls became common during the second half of the 1800's.

The public school served as a center of community activity throughout most of the 1800's. Spelling bees, town meetings, and other special events were held in the school. But community use of the school began to decline in the late 1800's, chiefly because many communities outgrew their school. The building was no longer large enough for community gatherings.

Improvements in school design began in the mid-1800's. Until that time, most school buildings were still made of wood and consisted of one room. All the children were taught together, without regard to grade level. Then in 1847, Quincy Grammar School in Quincy, Mass., divided students into grades and taught the grades separately. The school thus became the first graded public school in the United States. In 1848, Quincy Grammar School moved to a new building that had 12 classrooms. From that time on, most other new schools in towns and cities were designed with a separate room for each grade.

After about 1900, most schools were built of brick and concrete to meet stricter construction standards. Because earlier schools were built largely of wood, they presented a serious fire hazard. Schools also began to have special rooms in addition to regular classrooms. These special rooms included a gymnasium, a library, a science laboratory, and rooms for art and music classes. School designers also started to provide playground space around city schools.

As school design improved in the early 1900's, the school again became an important center of community activity. The new schools provided space for community gatherings. Also, the gymnasium and other new facilities were used for recreation and for evening classes.

The mid-1900's. The economic depression of the 1930's and World War II (1939-1945) interrupted the development of U.S. schools. After the war, the nation could again afford to invest in education. A greatly increased birth rate also created a need for more schools. As a result, a building boom in schools occurred across the nation in the late 1940's and the 1950's.

Recent developments. Several new kinds of schools were developed in the 1960's and 1970's. They were formed in part because of concerns that students found their studies in traditional schools dull and uninteresting. The new schools included community schools, alternative schools, and open schools. Many returned to more traditional practices during the 1980's.

Community schools were established to use school buildings and other facilities for a wide variety of community activities. Many remain open in the evening and during the summer. They offer courses for adults as well as children. Some community schools form part of a net-

work of learning resources in their communities.

Alternative schools were started by parents, religious organizations, and other private groups to offer help to students who did not do well in traditional schools. Alternative schools were often called *free schools,* because they gave students more freedom to decide what and how to study. Since the 1970's, many public school districts have developed their own alternative schools. Among the most popular are *magnet schools.* Most magnet schools stress a field of study—such as performing arts, mathematics, or science—and draw students from a wider attendance area than the neighborhood in which they are located.

Open schools were created in many school districts. The classrooms in these schools have movable walls, or there are no walls between class areas. This design lets teachers easily vary the organization of their classes.

During the 1980's and 1990's, U.S. public schools became the subject of a nationwide education reform effort. Many schools toughened their curriculum and requirements for graduation. Some schools tried to attract and retain able teachers by improving working conditions and raising salaries. In addition, more public school systems allowed parents to choose which schools their children will attend.

History of Canadian schools

Roman Catholic settlers from France set up the first schools in what is now Canada in the early 1600's. From then until the mid-1700's, the Catholic Church controlled most Canadian schools. Elementary schools, taught mainly by priests, provided instruction in reading, writing, arithmetic, and religion. Jesuit priests began a number of Latin schools, which were similar to the Latin grammar schools in the American Colonies.

Britain gained control of Canada in 1763. After that date, English settlers started many Protestant schools in Canada. These schools included both elementary schools and schools for boys who had completed their elementary education.

Canada's first public school systems were started after 1800. The British tried to create a single school system in Quebec for both French-speaking Roman Catholics and English-speaking Protestants. But Catholics opposed the plan. In the 1840's, Quebec established separate Protestant and Catholic school systems. Ontario, which was largely English-speaking and Protestant, set up a system of separate religious and public schools in the 1850's and 1860's.

The British North America Act, passed by the British Parliament in 1867, united Canada's provinces under one government. The act left education under provincial control. It also guaranteed public support for religious schools in Quebec, Ontario, and other provinces that had been providing such support.

During the late 1800's, elementary education became publicly financed and compulsory throughout Canada. The nation's first public high school was founded in Ontario in 1871, and kindergartens were introduced during the 1880's. During the early 1900's, new types of public schools opened. These included vocational high schools and schools for disabled people.

Canadian public school enrollment rose dramatically in the 1960's, reaching an all-time high in 1970. To meet the increased enrollments, many new schools were opened, including alternative schools and open schools. But lower birth rates cut enrollments in the 1970's and early 1980's. During the 1980's and 1990's, enrollment in preschool and other education programs increased, and many school programs expanded. Jack L. Nelson

Related articles. See Education and the *People* section of the state and province articles, and the *Education* section of various country articles. See also the following articles:

Kinds of schools

Alternative school
Charter school
Community college
Consolidated school
Correspondence school
Elementary school
High school
Junior high school
Kindergarten
Laboratory school
Middle school
Military school
Nursery school
Parochial school
Private school
Universities and colleges

Other related articles

Colonial life in America (Education)
Day care (Day care for school-age children)
Edison Project
Grading
Home schooling
Library (School libraries)
Parent-teacher organizations
Pioneer life in America (Education)
Safety (Safety at school)
School prayer
Special education
Teaching
Theater (Training for the theater)
Vocational education

Outline

I. Kinds of schools
A. Nursery schools
B. Kindergartens
C. Elementary schools
D. Middle schools
E. Junior high schools
F. High schools
G. Community colleges
H. Colleges and universities
I. Other kinds of schools

II. How schools operate
A. Public school districts
B. Public school operation
C. Private school operation
D. Financial support

III. History of U.S. schools

IV. History of Canadian schools

Questions

What are some of the general purposes of schools?
Which of the American Colonies passed the first law requiring establishment of public schools? When?
Where does almost all the financial support for U.S. and Canadian public schools come from?
When did widespread development of public schools begin?
What are *parochial schools*? *Nongraded schools*?
What levels of government set up public school districts in the United States and Canada?
How does the number of grades in high school vary according to the organization of a school district?
How did school design change in the United States during the mid-1800's?
What new kinds of schools were developed in the United States in the 1960's and early 1970's?

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School prayer, as a political issue in the United States, refers mainly to the practice of groups of public school students praying in school. Some people also use the term *school prayer* to refer to Bible readings and other religious activities in the schools. Private prayer by individual students is protected by law in the United States. However, Americans disagree about whether public schools should encourage students to engage in prayer or any other religious activity.

The Supreme Court of the United States has ruled in four major decisions that state-approved religious activities in schools violate the United States Constitution. In 1962, the court ruled in *Engel v. Vitale* that states cannot compose official prayers for students to recite. In *School District of Abington Township, Pennsylvania v. Schempp* (1963), the court decided that required daily Bible readings are also prohibited. In *Wallace v. Jaffree* (1985), the court ruled that a law encouraging students to observe a moment of silence for voluntary prayer violates the Constitution. In *Santa Fe Independent School District v. Doe* (2000), the court ruled that students could not lead public prayer sessions before high school football games.

The court based these rulings on the First Amendment to the Constitution, which prohibits government from endorsing religion or interfering with religious beliefs. Because public schools are supported by taxes, they are considered government institutions.

The First Amendment does not prohibit a student from praying in school. Instead, it prohibits public schools from being involved in the prayers or other religious activities of students. Moments of silence in which individual students may choose to pray are constitutional, so long as teachers neither instruct nor encourage students to use the time for prayer. Studies of religious history, literature, and music are constitutional if they are taught in an academic rather than a devotional manner.

Many Americans believe praying and experiencing other group religious activities in schools would nurture the moral character of students, and constitutional amendments to change the law have been proposed in Congress. Many other Americans believe the best way to protect individual religious beliefs is to leave the First Amendment as it has been since it was originally written. So far, none of the proposed amendments has gained enough support to become part of the Constitution.

Lynda Beck Fenwick

See also Church and state; Freedom of religion; Religious education.

Schooner. See Sailing (with picture).

Schopenhauer, *SHOH puhn HOW uhr,* **Arthur,** *AHR toor* (1788-1860), was a German philosopher who became widely known for his pessimistic views and his fine prose style. Schopenhauer was strongly influenced by the German philosopher Immanuel Kant. Following Kant's argument, Schopenhauer insisted that the world we experience through our senses is mere *representation.* By this he meant that we experience the world not as it really is, but only as we represent it to ourselves. In representing the world to ourselves, we change it.

Both Kant and Schopenhauer argued that we represent objects as existing in space and time, and we represent all events as having a cause. But according to these philosophers, space, time, and causality are not really properties of the world. Instead, we add them to our experience of the world. They are the structures we always necessarily use to organize our experience. But the price we pay for this ordering is never knowing the world as it really is—that is, as it exists apart from the structures we add to the world as we experience it.

Schopenhauer believed we can at least know ourselves without introducing this distortion. In addition to knowing ourselves as we know other things, we also experience ourselves from the inside as individuals making choices and willing certain ends. As Schopenhauer expressed it, we experience ourselves as *will* as well as *representation.* In knowing ourselves as will, we know ourselves apart from the structures of space, time, and causality. Thus, we know ourselves as we really are. For Schopenhauer, the real inner nature of the world is will.

Schopenhauer's pessimism was based on his belief that the will can never really be satisfied. According to Schopenhauer, the will is either striving for something that it unhappily does not yet possess, or it quickly experiences the boredom that invariably follows the attainment of any goal. Given the impossibility of ever satisfying the strivings of the will, Schopenhauer advised us to dissociate ourselves as much as possible from these strivings. He suggested that one important way of achieving this withdrawal is through the quiet contemplation of natural and artistic beauty.

Schopenhauer was born in Danzig (now Gdańsk, Poland). His most important book is *The World as Will and Representation* (1819, second edition 1844). A collection of essays titled *Parerga and Paralipomena* (1851) brought Schopenhauer international fame toward the end of his life. Ivan Soll

Schreyer, Edward Richard (1935-), was governor general of Canada from 1979 to 1984. The governor general serves as the representative of the British monarch, who is also Canada's head of state. After completing his term as governor general, Schreyer served as Canada's ambassador to Australia from 1984 to 1988.

In 1969, Schreyer became leader of the New Democratic Party in Manitoba and premier of the province. Schreyer was premier until 1977 and party leader until 1978. He was a member of the Manitoba Legislative Assembly from 1958 to 1965 and from 1969 to 1978. He served in the Canadian House of Commons from 1965 to 1969.

Schreyer was born in Beausejour, Manitoba. He graduated from the University of Manitoba. John T. Saywell

Schröder, Gerhard (1944-), became chancellor of Germany in 1998, succeeding Helmut Kohl. Schröder is the leader of the Social Democratic Party, the more liberal of Germany's two largest political parties.

Schroder worked to reduce Germany's high rate of unemployment and to raise the living standards of eastern Germans. He also redefined Germany's role in Europe and built strong relations with Russia, a former enemy.

Schröder was born in Mossenberg in Lower Saxony, a state in northwestern Germany. He left school at age 14 to work. He went to night school to complete his secondary education, finishing at age 22. He received a law degree from Göttingen University in 1976 and began practicing law in Hanover. From 1980 to 1986, he held a seat in the Bundestag, in Germany's national legislature. In 1986, he became a member of the Lower Saxony state

legislature. He was elected premier of Lower Saxony in 1990 and reelected in 1994 and 1998.

As a young man, Schröder was identified with the left wing of the Social Democratic Party. But he later adopted more moderate political views. James J. Sheehan

Schrödinger, *SHRAY dihng uhr,* **Erwin** (1887-1961), an Austrian theoretical physicist, became known for his mathematical equation describing the wavelike behavior of electrons. Schrödinger shared the 1933 Nobel Prize in physics with the British physicist Paul Dirac for this work and for other contributions to atomic theory.

Schrödinger developed his equation, now known as the "Schrödinger equation," in 1925 and introduced it in 1926. He based it on the ideas of Louis V. de Broglie, a French physicist, who in 1924 had proposed a theory that electrons behave like waves. The Schrödinger equation became the basis of a version of a field of physics called *quantum mechanics* (see Quantum mechanics).

In later years, Schrödinger concentrated on expanding Albert Einstein's theory of gravitation to include electrical and magnetic phenomena. Schrödinger was also interested in the impact of science and technology on philosophy. His short book *What Is Life? and Other Scientific Essays* (1956) details his concerns.

Schrödinger was born on Aug. 12, 1887, in Vienna. He was a professor of theoretical physics in several German and Swiss universities. He also was associated with the Dublin Institute for Advanced Studies. Richard L. Hilt

See also De Broglie, Louis V.; Dirac, Paul A. M.

Schubert, *SHOO buhrt,* **Franz Peter** (1797-1828), an Austrian composer, wrote an enormous variety of music in many forms. He was one of the greatest creators of melody, and perhaps the leading composer of *lieder* (German songs).

His life. Schubert was born on Jan. 31, 1797, in Vienna. He was the son of a poor schoolmaster. By the time he was 11, he was a choirboy. He attended school at the Imperial and Royal Seminary and played the violin and sometimes conducted there. Schubert was composing when only 13 and wrote his first song the next year. He began his first symphony in 1813. At 17, he wrote the well-known song "Gretchen at the Spinning Wheel." In 1815, he wrote his famous songs "Hedge Roses" and "The Erl King," as well as his second and third symphonies, and several works for the stage.

Schubert taught for a time in his father's school, and then went to live with his friend Ferdinand Schober in Vienna in 1816. Schubert's operas failed to earn much money, and he suffered from poverty because he lived a disorganized and easygoing life. He composed constantly and gained some recognition but managed to get only a few works published. He never achieved real success during his lifetime.

Schubert planned to visit Hungary in 1828, a year in which he composed several major works. But he became very ill and had to abandon the trip. On Nov. 14, 1828, he contracted typhus. He died five days later.

Schubert was a classic example of a man of genius so devoted to his art that he never adjusted to the world in which he lived. He never married. His music and personal charm won him admiring friends, but he gained little public recognition. Schubert heard only a few of his great orchestral works performed, and his great Symphony in C major was not performed during his lifetime. Ten years after his death, his brother Ferdinand gave the manuscript to Robert Schumann. Schumann in turn gave it to Felix Mendelssohn, who conducted the work in Leipzig (now in Germany). Ferdinand made many of Schubert's works available for publication.

His works. Schubert's orchestral works include dances, overtures, and symphonies. The two-movement Symphony No. 8 in B minor ("Unfinished") has long been popular. Many regard Schubert's Symphony in C major (known either as No. 7 or No. 9) as his greatest masterpiece. His charming chamber music varies from an octet and two quintets to many string quartets and piano trios, as well as sonatas for piano and violin. Schubert also wrote many pieces for solo piano, notably sonatas, *impromptus,* waltzes, and *Moments Musicaux (Musical Moments).* He also composed many piano duets.

Schubert was especially attracted to the musically expressive possibilities of the human voice. He composed much religious music, including Masses, and choral pieces to nonreligious texts. He wrote several operas and operettas, which lacked theatrical effectiveness and failed. However, Schubert's incidental music for the play *Rosamunde, Princess of Cyprus,* is still popular.

Schubert's special contribution to music lies in his more than 600 solo lieder. These include the two *cycles* (groups of related songs) called *Die schöne Müllerin (The Beautiful Mill-Girl)* and *Winterreise (Winter Journey),* and a collection of songs called *Schwanengesang (Swan Song).* Such separate songs as "Ave Maria," "Death and the Maiden," "Serenade," "The Trout," and "Who Is Sylvia?" are among the greatest in song literature. No other composer has written so many expressively beautiful songs of such high quality. See Lieder.

Schubert was not a man of searching and tough-fibered intellect like Ludwig van Beethoven, a man he admired greatly. Schubert sometimes was unable to sustain his musical ideas once he had presented them in larger forms. Some critics feel that many of his sonatas are too long for the musical ideas they contain. This problem does not arise in his lieder, which are relatively brief and include a wealth of varied material. Schubert seems to have excelled in shorter forms. His songs would have placed him among the great composers even if he had written nothing more. Daniel T. Politoske

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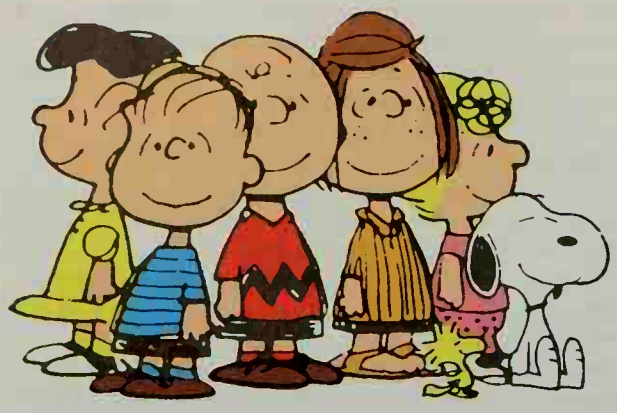
Schulz, *schults,* **Charles Monroe** (1922-2000), created the "Peanuts" comic strip. His simply drawn characters are children who make funny but wise statements about life. Charlie Brown, Lucy, Linus, Snoopy the dog, and the others appealed to both children and adults.

Schulz was born on Nov. 26, 1922, in Minneapolis, Minnesota. He based much of the Charlie Brown character on his own childhood. Schulz had trouble with his studies because he skipped two grades. In high school, he did poorly in sports and was too shy to ask a girl for a date. The high school yearbook even rejected his cartoons. But Schulz continued to draw and, in the late 1940's, he began selling cartoons to magazines and newspapers. In 1950, he started "Peanuts," with Charlie Brown, a born loser, as the main character. Late in 1999, Schulz announced he was retiring from drawing "Pea-



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Popular "Peanuts" characters created by Charles Schulz include, *from left to right,* Lucy, Linus, Charlie Brown, Peppermint Patty, Sally, Woodstock the bird, and Snoopy the dog.

nuts" for health reasons. Schulz drew by hand all 18,000 "Peanuts" comic strips that eventually appeared in over 2,000 daily newspapers in 75 countries. Charles P. Green

Schuman, *SHOO muhn,* **William** (1910-1992), was an American composer and educator. His music features energetic melodies, lively rhythms, and brilliant orchestrations. In 1943, Schuman won the first Pulitzer Prize awarded for music. He received it for his composition, *A Free Song* (1943), written for chorus and orchestra.

Schuman wrote mainly for band, chorus, or orchestra. His Symphony No. 3 (1941) is the most widely performed of his 10 symphonies. *New England Triptych* (1956) is an orchestral work adapted from melodies by American composer William Billings. Schuman also wrote several ballets and *The Mighty Casey* (1953, revised 1976), an opera about a fictional baseball player.

William Howard Schuman was born on Aug. 14, 1910, in New York City. He was president of the Julliard School of Music from 1945 to 1962 and president of the Lincoln Center for the Performing Arts in New York City from 1962 to 1969. Leonard W. Van Camp

Schumann, *SHOO mahn,* **Clara** (1819-1896), was one of the finest concert pianists of her time. She especially promoted the piano music of her husband, Robert Schumann, and their close friend Johannes Brahms. She influenced the compositions of both men by giving them insightful and useful suggestions. She was also a capable composer of songs and piano works, though she never intended to be a professional composer.

Schumann was born Clara Wieck on Sept. 13, 1819, in Leipzig, Germany. She met Robert Schumann while he was studying piano with her father, Friedrich Wieck. They were married in 1840. The couple had eight children. They settled in Düsseldorf in 1850 and met Brahms in 1853. Robert suffered from mental illness and was placed in a mental institution in 1854. Clara then had to raise their children alone. In 1878, she was appointed principal teacher of piano at the conservatory in Frankfurt. While there, she prepared editions of her husband's compositions and letters for publication..

Daniel T. Politoske

See also Schumann, Robert.

Schumann, *SHOO mahn,* **Robert** (1810-1856), was a German composer and writer on music. Some critics consider him to be the most important composer of the German romantic movement. Schumann became best known for his piano compositions and songs.

His works. Schumann's compositions represent the two contrasting moods of romantic music and two aspects of his personality. One is the emotional, impulsive, stormy extrovert represented in the musical sketch "Florestan" from the piano composition *Carnaval* (1834-1835). The other is the quiet, introspective dreamer "Eusebius," also from *Carnaval.*

Schumann's chief works for piano include *Symphonic études* (1834), a Fantasia in C major (1836), and a Concerto in A minor (1845). He also composed short pieces, many of which he organized in groups. These include *Papillons* (1829-1831), *Kinderscenen* (1838), *Kreisleriana* (1838), and *Album for the Young* (1848).

Schumann composed four symphonies; chamber and choral music; an unsuccessful opera, *Genoveva* (1850); and other works. His songs rank with those of Franz Schubert among the finest German *lieder* (art songs). In 1840, the year he married, he wrote over 100 songs.

Schumann had a strong influence on various composers of the late 1800's, especially Johannes Brahms of Germany and Edvard Grieg of Norway. He also influenced several French and Russian composers.

In 1833, Schumann helped found the *Neue Zeitschrift für Musik,* a leading music journal. He edited the journal from 1835 to 1844 and wrote many articles for it until 1853. These articles did much to establish the early reputation of such composers as Brahms of Germany, Hector Berlioz of France, and Frédéric Chopin of Poland.

His life. Schumann, the son of a bookseller and publisher, was born on June 8, 1810, in Zwickau. He began piano lessons at the age of about 7. In 1828, Schumann entered the University of Leipzig with the goal of studying law. But he neglected his studies and devoted most of his time to music and writing. After a year at the University of Heidelberg, he returned to Leipzig in 1830. Schumann studied piano under the noted teacher Friedrich Wieck. But he injured a finger in 1832, which forced him to abandon his hopes for a career as a concert pianist.

About 1835, Schumann fell in love with Wieck's 16-year-old daughter Clara, a brilliant pianist. Wieck felt that Clara was too young and Schumann's future too uncertain for marriage. Despite his objections, the couple were married in 1840 (see **Schumann, Clara**).

Schumann began to show signs of mental illness in the early 1840's, and he later suffered a severe breakdown. He accepted the position of musical director of the Düsseldorf symphony orchestra in 1850, but his increasing mental illness caused difficulties with the musicians. Schumann resigned in 1853. Early in 1854, he tried to commit suicide by jumping into the Rhine River. He was rescued and placed in an asylum, where he died two years later. Lydia Hailparn Ledeen

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Schumpeter, *SHOOM pay tuhr,* **Joseph Alois,** *YOH zehf ah LOYS* (1883-1950), was a noted economist of the first half of the 1900's. He gained prominence for his

studies of economic growth, business cycles, and the conflict between capitalism and socialism.

In his first major work, *The Theory of Economic Development* (1911), Schumpeter argued that growth in a private enterprise economy was caused by daring *entrepreneurs* (business organizers) who hope to make large profits. The entrepreneur did something new. The innovation might be a new product, invention, or process that would lead to new industries and markets. In *Business Cycles* (1939), Schumpeter wrote that new developments generally came irregularly and in bunches. He said this tendency created cycles of good and bad times.

In *Capitalism, Socialism, and Democracy* (1942), Schumpeter said that government efforts to reduce unequal distribution of income and to eliminate business cycles would destroy the conditions in which entrepreneurs could flourish, and that the growth of big business would eliminate the entrepreneurs from decision-making positions in industry. Capitalism would then lose its ability to grow and develop, and the resulting economic conditions would lead to socialism.

Schumpeter was born near Jihlava, in what is now the Czech Republic, and was educated at the University of Vienna. He taught briefly at Harvard University in the late 1920's, joining its regular faculty in 1932. He became a United States citizen in 1939. Daniel R. Fusfeld

Schurz, *shurtz* or *shoorts,* **Carl** (1829-1906), was an American editor, soldier, and political leader. He became one of the most famous United States citizens of German birth. Schurz was born at Liblar, Prussia, near what is now Cologne, Germany, and attended the University of Bonn. He fought in the revolution of 1848-1849 against the autocratic rulers of the German states. After the revolution failed, he escaped to Switzerland. Schurz made his way to the United States in the early 1850's.

Schurz settled in Wisconsin and became a leader in the antislavery fight. He campaigned for Abraham Lincoln in the election of 1860. Lincoln named him minister to Spain. During the early years of the Civil War, Schurz was in Madrid safeguarding the Union cause. Later, he became a brigadier general in the Union Army.

After the Civil War ended in 1865, Schurz became coowner of the *Westliche Post,* a German-language newspaper, in St. Louis, Missouri. The paper soon became a powerful influence in the West. In 1869, he was elected a Republican U.S. senator from Missouri, and soon became a leader of the opposition to President Ulysses S. Grant. He helped form the Liberal Republican Party, which nominated publisher Horace Greeley to run against Grant in 1872.

President Rutherford B. Hayes appointed Schurz secretary of the interior in 1877, a post he held until 1881. As secretary, he argued for fair treatment of American Indians and installed a civil service merit system in his department (see Civil service). Later, he became editor of the New York *Evening Post.* He was chief editorial writer for *Harper's Weekly* from 1892 to 1898. Schurz's wife, Margaretha Meyer Schurz, founded the first kindergarten in the United States. She established the school in Watertown, Wisconsin, in 1856. Michael Emery

Bettmann Archive

Carl Schurz

Schuyler, *SKY luhr,* **Philip John** (1733-1804), was an American soldier and statesman. At the start of the Revolutionary War in 1775, he was a delegate to the Continental Congress. After the battle of Bunker Hill, he was made a major general in the Continental Army.

In 1777, British forces under General John Burgoyne advanced from Canada into New York. Schuyler's troops delayed the British by destroying bridges and felling trees across the road. This delay contributed to Burgoyne's surrender, which took place at Saratoga. From 1789 to 1791 and in 1797 and 1798, Schuyler served as a U.S. senator from New York. He was born in Albany, New York. James H. Hutson

Schuylkill River, *SKOOL kihl,* is an important river in Pennsylvania. It rises in Schuylkill County and flows southeast for about 131 miles (211 kilometers) before it empties into the Delaware River at Philadelphia. It furnishes power, and part of Philadelphia's water supply. Coal barges use the river, which has been equipped with dams and locks. William C. Rense

Schwartz, Delmore (1913-1966), was an American poet. Most critics consider his lyric poems of the 1930's and early 1940's to be his most important works. In those early poems, Schwartz expressed his belief that knowledge is the key to achieving responsible individuality. But he also believed that knowledge always brings disillusionment. His poetry reflected his conviction that people's only firm basis for living is the recognition of their inevitable death and of their need for others.

Schwartz gained fame for his first collection of poems, *In Dreams Begin Responsibilities* (1938). His last collection, *Summer Knowledge* (1959), contains all his lyric poems as well as some later less successful works. Schwartz also wrote a number of short stories that reflect his middle-class Jewish background. Many of these stories appear in *The World Is a Wedding* (1948) and *Successful Love* (1961). His writings on literature and motion pictures were collected in *Selected Essays,* published in 1970 after his death.

Schwartz was born in New York City. From 1943 to 1955, he was an editor for *Partisan Review* magazine. He also taught at several universities. Elmer W. Borklund

Schwarzkopf, H. Norman (1934-), was a general in the United States Army. He commanded the U.S. forces in the Persian Gulf War (1991). Over 540,000 men and women served in the ground, sea, and air forces under his command.

H. Norman Schwarzkopf was born in Trenton, New Jersey, the son of a major general in the U.S. Army. He graduated from the United States Military Academy and received a master's degree in mechanical engineering from the University of Southern California. During the Vietnam War (1957-1975),

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H. Norman Schwarzkopf

Schwarzkopf served twice in Vietnam—in 1965 and 1966, and in 1969 and 1970. He then commanded troops in the United States and held staff positions in the Pentagon. During the U.S. military operation in Grenada in 1983, Schwarzkopf was deputy commander of the joint task force and principal Army adviser. In 1988, he was appointed commander in chief of U.S. Central Command, the headquarters for military operations in 18 countries of Africa and Asia. Schwarzkopf retired from the Army in August 1991. Joel D. Meyerson

Schweitzer, *SHWYT suhr* or *SHVYT suhr,* **Albert** (1875-1965), was a brilliant philosopher, physician, musician, clergyman, missionary, and writer on theology. His accomplishments in any one of these fields could be regarded as a full life's work for one person.

Schweitzer has been called one of the greatest Christians of his time. He based his philosophy on what he called "reverence for life" and on a deep feeling of obligation to serve humanity through thought and action. Schweitzer's many years of work as a humanitarian won for him the 1952 Nobel Peace Prize.

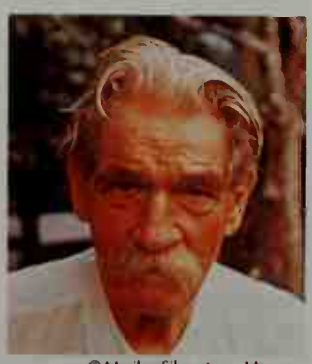
His life. Schweitzer was born on Jan. 14, 1875, at Kaysersberg, a town near Strasbourg in the region of Alsace, Germany (now France). He was educated in France and Germany. At age 21, Schweitzer decided to spend his next nine years in science, music, and preaching, and then to devote the rest of his life to serving humanity directly. Before he was 30, he had won worldwide fame as a writer on theology, as an organist and authority on organ building, as an interpreter of Johann Sebastian Bach's works, and as an authority on Bach.

In 1902, Schweitzer became principal of St. Thomas Theological College at the University of Strasbourg. He was inspired to become a medical missionary, and studied medicine at the university. He raised money for a hospital at Lambaréné, French Equatorial Africa (now Gabon), from his parishioners and by giving concerts for the Paris Bach Society, which he had helped found. In 1913, he began serving at Lambaréné.

Schweitzer's first consulting room was a chicken coop. Over the years, he built a large hospital and a medical station where thousands of Africans were treated yearly. Schweitzer used his $33,000 Nobel Prize to expand the hospital and establish a leper colony.

His books. Schweitzer continued to write while in Africa. He completed in 1923 the first two volumes of his monumental work *The Philosophy of Civilization.* These books are *The Decay and Restoration of Civilization* and *Civilization and Ethics.* His other works include *The Quest of the Historical Jesus* (1906), *Out of My Life and Thought* (1931), and *From My African Notebook* (1939).

In 1949, Schweitzer spoke at the Goethe Bicentennial Convocation at Aspen, Colorado. In 1955, Queen Elizabeth II conferred Britain's highest civilian award, the Order of Merit, on Schweitzer. In 1957, Schweitzer went on record as opposing further atomic weapons tests because of the danger of radioactive fallout to human beings. James Bentley



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Albert Schweitzer

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Schwenkfelders, *SHVEHNGK FEHL duhrz,* are an American Protestant group that originated in Silesia (now part of Poland). They live in southeastern Pennsylvania, where there are five Schwenkfelder churches with a total of about 3,000 members. Schwenkfelders believe that the spiritual life of the individual is the basis of religious faith. For this reason, they tolerate a variety of beliefs. They conduct simple worship services. They emphasize education, Biblical study, and conservative life styles. Schwenkfelders are active missionaries.

The Schwenkfelder Church follows the teachings of Caspar Schwenkfeld von Ossig, a German religious reformer of the 1500's. During the early 1700's, church members suffered religious persecution in Silesia. More than 500 Schwenkfelders fled to Germany, and 208 of them moved to America between 1731 and 1737, seeking religious freedom. They settled near Philadelphia, and most became farmers. The European Schwenkfelders died out by the early 1800's. Craig W. Horle

Schwitters, *SHVIHT uhrs,* **Kurt** (1887-1948), was a German artist known for creating pictures out of glued paper and other objects. These works are called *collages.* In 1918, Schwitters became involved with the Dada art movement. The Dadaists believed that significant art could be created from accidental and shocking events. Much Dada art was political and attacked Western social institutions. Schwitters, in contrast, created a personal and nonpolitical art form he called *Merz.* The *Merz* works were collages made from paper, paint, and everyday objects, such as stamps and bus tickets. A *Merz* picture appears in the **Collage** article. Schwitters's desire to blend art and life led him to turn his homes into a work of art. He attached printed matter and rubbish, such as driftwood and wheel parts, to the walls, and called the houses *Merzbauten* (Merz structures).

Schwitters was born on June 20, 1887, in Hanover, where he operated an advertising agency and graphic design studio. He also wrote poetry. In 1937, the Nazi rulers of Germany declared his art "degenerate." He fled to Norway and finally to England in 1940, where he died. Joseph F. Lamb

See also **Avant-garde; Dadaism.**

Sciatica, *sy AT uh kuh,* refers to pain along the *sciatic nerve.* The sciatic nerve extends from the pelvis down the back of each leg to the foot. It controls feeling and movement in the leg and foot. The most common cause of sciatica is pressure on one of the nerve roots that form the sciatic nerve. For example, pressure from a ruptured *intervertebral disk* in the lower spine may cause sciatica. In such cases, part of the tissue that makes up the disk protrudes from the vertebrae of the spine and presses on a nerve root. The person feels pain in the leg and foot, as well as the spine. Treatment for most cases of sciatica consists of bed rest and certain exercises. In some cases, surgery is required to remove the pressure on the nerve. James N. Campbell

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A biologist studying a photo of viruses

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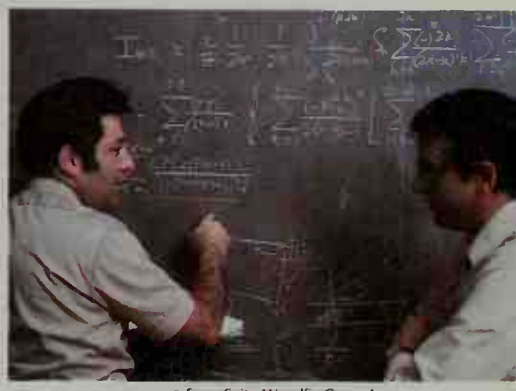
An astronomer readying his telescope

Cindy Rymer, Click/Chicago

Archaeologists working at a dig



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Mathematicians solving problems

The world of science consists of many fields of study. For example, scientists may investigate the structure of galaxies or the way tiny organisms function. They may explore the remains of past cultures or prove mathematical statements. New areas of scientific research are continually emerging.

Science

Science covers the broad field of knowledge that deals with observed facts and the relationships among those facts. The word *science* comes from the Latin word *scientia*, which means *knowledge*. Scientists study a wide variety of subjects. For example, some scientists search for clues to the origin of the universe. Other researchers examine the structure of molecules in the cells of living plants and animals. Still others investigate why we act the way we do, or try to solve complicated mathematical problems. But in whatever field they work, all scientists explore the workings of the world.

Scientists use systematic methods of study to make observations and collect facts. They then work to develop theories that help them order or unify related facts. Scientific theories consist of general principles or laws that attempt to explain how and why something happens or happened. Science advances as scientists accumulate more detailed facts and gain a better understanding of these fundamental principles and laws.

A theory developed by a scientist cannot be accepted as part of scientific knowledge until it has been verified by the studies of other researchers. In fact, for any knowledge to be truly scientific, it must be repeatedly tested experimentally and found to be true. This characteristic of science sets it apart from other branches of knowledge. For example, the *humanities*, which include religion, philosophy, and the arts, deal with ideas about human nature and the meaning of life. Such ideas cannot be scientifically proved. There is no test that tells whether a philosophical system is "right." No one can determine scientifically what feeling an artist tried to express in a painting. Nor can anyone perform an experiment to check for an error in a poem or a symphony.

Science also differs from other types of knowledge in that scientific progress depends on new ideas expanding or replacing old ones. Great works of art produced today do not take the place of masterpieces of the past. But the theories of modern scientists have revised many ideas held by earlier scientists. Repeated observations and experiments lead scientists to update existing theories and to propose new ones. As new discoveries continue to be made, even many recent scientific theories will become outdated and will have to be replaced by better theories that can explain more facts. In this way, scientific knowledge is always growing and improving.

Joseph W. Dauben, the contributor of this article, is Professor of History and the History of Science at the City University of New York.

The importance of science

Science has enormous influence on our lives. It provides the basis of much of modern *technology*—the tools,materials, techniques, and sources of power that make our lives and work easier. The term *applied sci-*

ence is sometimes used to refer to scientific research that concentrates on the development of technology. The discoveries of scientists also help shape our views about ourselves and our place in the universe.

To everyday life. Modern science and technology have changed our lives in many dramatic ways. Airplanes, automobiles, communications satellites, computers, plastics, and television are only a few of the scientific and technological inventions that have transformed human life. Research by nuclear physicists has led to the development of nuclear energy as a source of power. Agricultural output has soared as scientists have developed better varieties of plants and highly effective fertilizers. The development of antibiotics and other new drugs has helped control many infectious diseases. Studies in anatomy and physiology have led to amazing new surgical techniques and to the invention of lifesaving machines that can do the work of such organs as the lungs, kidneys, and heart.

Although scientific and technological achievements have benefited us in numerous ways, they have also created serious problems. The rapid growth of industrial technology, for instance, has resulted in such grave side effects as environmental pollution and fuel shortages. Breakthroughs in nuclear research have led to the development of weapons of mass destruction. Some people fear that advanced biological research will produce new disease-causing bacteria or viruses that resist drugs. People are also concerned that computerized information systems may destroy personal privacy.

The harmful effects of some technological applications of science have led some people to question the value of scientific research. But science itself is neither good nor bad. The uses that businesses, governments, and individuals choose to make of scientific knowledge determine whether that knowledge will help or harm society. For a more detailed discussion of the benefits and side effects of technology, see **Technology.**

To philosophical thought. Science has greatly affected the way we view ourselves and the world around us. In ancient times, most people believed that natural events and everything that happened to them resulted from the actions of gods and spirits. For example, they thought that angry gods and evil spirits caused disease by invading or attacking the body.

The ancient Greeks were among the first peoples to begin to use systematic observation and reasoning to analyze natural happenings. As scientific thinking gradually developed, nature came to be seen less and less as the product of mysterious spiritual forces. Instead, people began to feel that nature could be understood and even controlled through science.

Over the years, scientific findings have increasingly influenced philosophical and religious thought about the nature of human beings and their place in the universe. In the mid-1500's, for example, the Polish astronomer Nicolaus Copernicus proposed that the earth and the other planets travel around the sun. Although his theory was later proved to be correct, it stirred strong opposition among philosophers and religious leaders of the time. They had long believed that the earth and the people on it had special importance because the sun, stars, and planets seemed to revolve around the earth.

The theories developed by the British naturalist Charles Darwin in the mid-1800's also aroused bitter philosophical and religious debates. Some philosophers and religious leaders opposed Darwin's idea that all species of plant and animal life *evolved* (developed gradually) from a few common ancestors. They felt that this theory of evolution contradicted the belief that God created human beings and gave them special emotional and intellectual gifts. These debates continue today. During the late 1800's and early 1900's, the Austrian physician Sigmund Freud developed a theory that unconscious motives control much of human behavior. His research and writings have raised serious questions about the extent to which people have free will and are responsible for their behavior. See **Evolution** (Acceptance of evolution); **Freud, Sigmund** (His influence).

Since 1900, new scientific theories have begun to alter philosophical views about the nature of reality and the limits of our ability to observe it accurately. In 1905, for instance, the German-born physicist Albert Einstein published his special theory of relativity. The theory dramatically changed some of the most basic ideas about time, space, mass, and motion. For example, it stated that observations of space and time are not absolute. They are affected by the motion of the observer. See **Relativity.**

The branches of science

Scientific study can be divided into four major groups: (1) mathematics and logic, (2) the physical sciences, (3) the life sciences, and (4) the social sciences. Within these main categories are many smaller groupings of closely related specialties. For example, anthropology, psychology, and sociology are *behavioral sciences* included in the category of the social sciences. Geology, meteorology, physical geography, and physical oceanography are grouped together as the *earth sciences* within the category of the physical sciences.

As scientific knowledge has grown and become increasingly complicated, many new fields of study have emerged. At the same time, the boundaries between scientific fields have become less and less clear-cut. Numerous areas of science overlap, and it is often hard to tell where one science ends and another begins. For instance, both chemistry and physics deal with atomic structure. Both paleontology and geology study the age of rocks in the earth. Many of the most important scientific advances have resulted from the exchange of ideas and methods among different branches of science.

In some cases, sciences have come to overlap so much that *interdisciplinary* fields have been established. Such fields combine parts of two or more sciences. For example, *biochemistry* combines areas of biology and chemistry in studying the chemical processes that occur in living plants and animals. *Economic geology* draws upon economics and geology in investigating the distribution of such natural resources as gold, silver, and petroleum.

World Book has separate articles on many of the branches of science discussed in this section. For a complete listing of these articles, see the *Related articles* at the end of this article.

Mathematics and logic are not based on experimental testing. But they can be considered part of science because they are essential tools in almost all scien-

tific study. Mathematics enables scientists to prepare exact statements of their findings and theories and to make numerical predictions about what will happen in the future. Logic provides the basis for all scientific reasoning.

Mathematics has a number of major branches. *Arithmetic,* which furnishes the basis for many of the other branches of mathematics, is the study of numbers and of methods for calculating with numbers. *Algebra* involves solving *equations,* mathematical sentences that say two expressions are equal. In algebraic equations, letters are used to represent unknown quantities. *Calculus* is used to solve problems dealing with changing quantities. *Geometry* concerns the mathematical relationships of points, lines, angles, surfaces, and solids in space. *Probability* deals with the likelihood that an event will occur. *Statistics* is used to analyze large amounts of numerical information for significant trends.

Scientific reasoning depends on both *deductive logic* and *inductive logic.* In using deductive logic, a scientist reasons from known scientific principles or rules to draw a conclusion relating to a specific question. The accuracy of the scientist's conclusion depends on the accuracy and completeness of the principles or rules used. Inductive logic requires a scientist to make repeated observations of an experiment or an event. From the many observations, the scientist can form a general conclusion. See **Deductive method; Inductive method.**

The physical sciences examine the nature of the universe. They study the structure and properties of nonliving matter, from tiny atoms to vast galaxies. The physical sciences include (1) astronomy, (2) chemistry, (3) geology, (4) meteorology, and (5) physics.

Astronomy is the study of comets, meteors, galaxies, planets, stars, and other objects in space. Astronomers map the locations of heavenly bodies and investigate the physical and chemical processes that occur in celestial objects. They also study the structure, composition, size, and history of the universe.

Chemistry studies natural and artificial substances to determine their composition and structure and the changes that occur when they combine and form other substances. Chemists take molecules apart and put them together in new ways. They try to find out why chemical reactions occur and how they can be controlled. *Organic chemistry* deals with most compounds containing the element carbon, and *inorganic chemistry* concerns all other compounds. *Radiochemistry* investigates radioactive substances and their uses. *Stereochemistry* examines the different chemical properties that result when compounds of the same formula differ in the relative position of their atoms in three-dimensional space. *Physical chemistry* studies the effects of light, heat, and other forms of energy on chemical processes.

Geology investigates the composition, structure, and history of the earth. Geologists analyze how such forces as earthquakes, volcanic eruptions, and wind or water erosion change the earth's surface. They also study meteorites and materials brought back from the moon. Branches of geology include *petrology,* the study of rocks; *mineralogy,* the study of minerals; and *seismology,* the study of earthquakes. *Geochronology* seeks to determine the age and history of the earth and its parts.

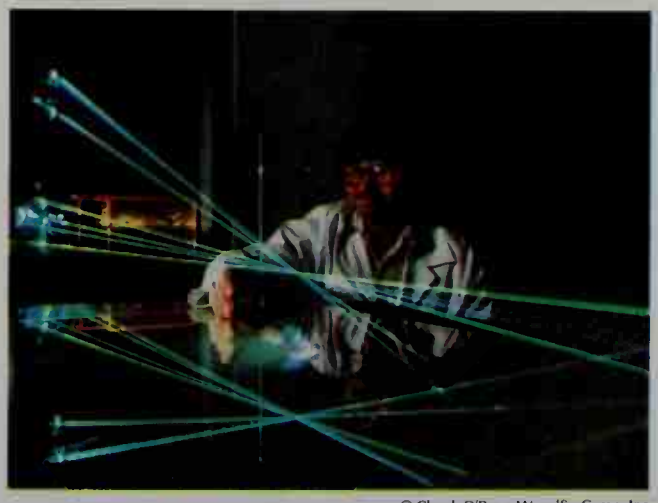
Meteorology is the study of the earth's atmosphere and the conditions that produce weather. Meteorologists try to predict the weather. They work to develop improved instruments for collecting data about the atmosphere. They also seek better techniques to make weather forecasting more exact. *Climatologists* analyze weather trends to determine the general pattern of weather that makes up an area's climate.

Physics is concerned with matter and energy. Physicists study mechanics, heat, light, sound, electricity, magnetism, and the properties of matter. *Atomic physics* involves the study of the structure and properties of atoms, and *nuclear physics* focuses on the makeup and behavior of the nuclei of atoms. *Particle physics* deals with the nature of electrons, protons, and other tiny bits of matter smaller than atomic nuclei. *Cryogenics* examines the behavior of matter at extremely low temperatures, and *plasma physics* investigates the behavior of gases that ionize to create a form of matter called plasma. *Solid-state physics* studies the properties of extremely pure crystals and other solid materials.

The life sciences, also called the *biological sciences* or *biology,* involve the study of living organisms. There are two main fields of the life sciences. *Botany* deals with plants, and *zoology* with animals. Botany and zoology are further divided into various branches, each of which can be subdivided into areas of special study. Most major branches of the life sciences apply equally to plants and animals. Many of the branches, such as anatomy and physiology, overlap with, and contribute greatly to, the study of medicine. See Medicine.

Anatomy examines the structure of living things. Anatomists investigate the parts of organisms and how the parts are related. *Histology* deals with tissues, and *cytology* with the fine structures of individual cells. *Comparative anatomy* studies similarities and differences in the body structure of animals and provides clues to how certain animals might have evolved.

Physiology deals with the normal functions of living things and their parts. For example, physiologists study how nerve fibers transmit impulses and how organisms take in and use food. *Biochemistry* examines the chemical processes that are involved in the actions of the different parts of plants and animals. *Biophysics* investi-



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Modern technology plays a key role in almost every area of scientific research. The physicist above is using *lasers* (concentrated beams of light) in measuring airstream velocity.

gates the physical processes involved in the functioning of the various parts of living things.

Other branches. The field of *genetics* is concerned with how plants and animals pass on characteristics to their offspring. *Molecular biology* examines the structure and function of proteins and other large molecules essential to life. *Paleontology* investigates the forms of life that existed in prehistoric times. *Taxonomy* involves the classification of living things. *Sociobiology* deals with the biological basis for the social behavior of people and other animals. *Ecology* focuses on the relationships living things have to one another and to their environment.

Some life sciences concentrate on certain kinds of organisms. For example, *bacteriology* is the study of bacteria, and *ornithology* is the study of birds. Some other life sciences investigate the organisms that live in a specific environment. *Marine biology*, for instance, studies the plants and animals of the sea.

The social sciences deal with the individuals, groups, and institutions that make up human society. They focus on human relationships and the interactions between individuals and their families, religious or ethnic communities, cities, governments, and other social groups. Social scientists attempt to develop general "laws" of human behavior. But their task is difficult because it is hard to design controlled experiments involving human beings. Social scientists must therefore rely heavily on careful observations and the systematic collection of data to arrive at their conclusions. The use of statistics and mathematical models is important in analyzing information and developing theories in the social sciences. The main branches of the social sciences include (1) anthropology, (2) economics, (3) political science, (4) psychology, and (5) sociology.

Anthropology investigates the origin and development of human cultures and of human physical characteristics. Anthropologists study various groups of people to determine their similarities and differences. They compare the arts, beliefs, customs, daily life, inventions, languages, social relationships, and values of different cultures. *Archaeology* traces cultural development by studying the things earlier peoples made and used.

Economics examines how people produce goods and services, how they distribute them among themselves, and how they use them. Economists deal with problems in such areas as management and labor relations, the setting of wages and prices, and the use of natural resources. They use computers and statistical analysis to construct mathematical models that enable them to determine how various economic systems work and to predict the effect of changes in the systems.

Political science studies forms of government, political parties, pressure groups, elections, and other aspects of politics. Political scientists try to develop theories about political power and behavior and seek to discover what kinds of government may benefit people the most under given circumstances. They also measure public opinion.

Psychology involves investigation of mental processes and behavior. *Physiological psychologists* study how the nerves and the brain work. *Behavioral psychologists* observe and record the ways in which people and other animals relate to one another and to the environment. They use systematic methods to examine people's thoughts, feelings, and personality traits. Psychologists also explore the causes of mental disorders and possible methods of treatment.

Sociology studies the nature, origin, and development of human society and community life. Sociologists investigate the interrelationships among individuals and groups in a society. They examine cultural influences, standards of behavior, and other factors that can affect general social conditions. They also explore the causes of crime, divorce, poverty, and other social problems.

How scientists work

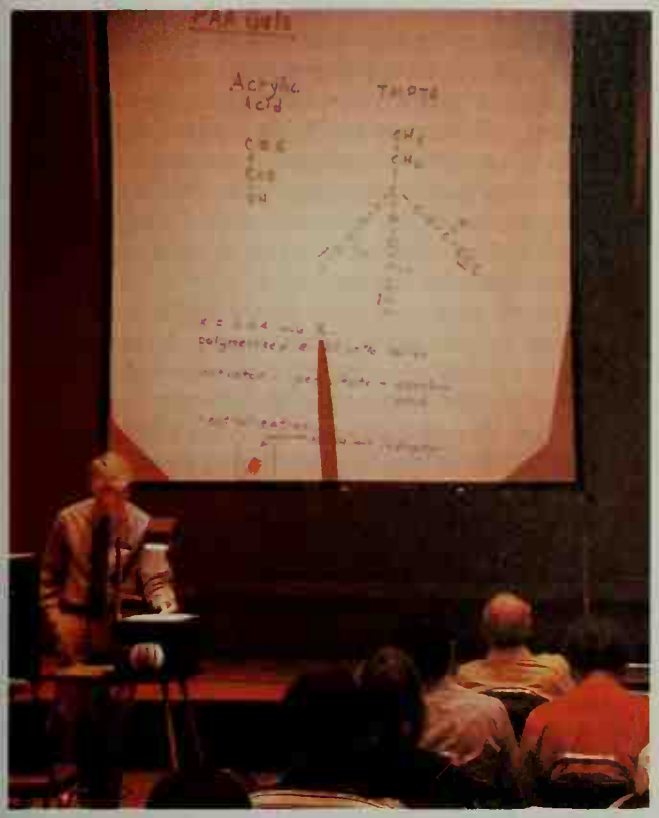
Scientific research is a creative process that can involve a variety of techniques. Important advances may result from patient hard work or sudden leaps of imagination. Even chance can play a role in the scientific process. For example, Sir Alexander Fleming, a British bacteriologist, discovered penicillin accidentally in 1928, when he noticed that a bit of mold of the genus *Penicillium* had contaminated a laboratory dish containing bacteria. Examining the dish, Fleming saw that the bacteria around the mold had been killed.

Scientists use a number of methods in making discoveries and in developing theories. These methods include (1) observing nature, (2) classifying data, (3) using logic, (4) conducting experiments, (5) forming a *hypothesis* (proposed explanation), (6) expressing findings mathematically, and (7) modeling with computers. Most scientific research involves some or all of these steps.

Observing nature is one of the oldest scientific methods. For example, the ancient Egyptians and Babylonians studied the motions of heavenly bodies and so learned to predict the changes of seasons and the best times to plant and harvest crops. In the 1830's, Charles Darwin carefully observed plants and animals in many parts of the world while serving as a naturalist with a British scientific expedition aboard the H.M.S. *Beagle*. Study of the specimens collected on the voyage helped Darwin develop his theory that modern species had evolved from a few earlier ones.

Classifying data can reveal the relationships among observed facts. In the mid-1800's, Dmitri Mendeleev, a Russian chemist, classified the elements into families or groups in a chart called the *periodic table*. On the table, elements with similar properties appeared at regular intervals. Gaps in the table indicated elements that were not yet known. Scientists later proved the importance of Mendeleev's systematic classification when they discovered the existence and chemical properties of new elements that filled the gaps.

Using logic enables scientists to draw conclusions from existing information. In the late 1800's, a German physicist named Wilhelm Wien studied the relationship between temperature and the energy radiated by heated solids and liquids. After studying many specific examples, he noted that multiplying the temperature of a heated solid or liquid by the wavelength of greatest intensity radiated at that temperature always produced the same number. Although Wien could not test all solids and liquids, he used inductive reasoning to conclude that this number was a *universal constant* which was the same for all heated solids and liquids, regardless of their physical or chemical makeup.



WORLD BOOK photo by Ralph J. Brunke

Scientific gatherings provide a place where scientists can share ideas and discuss discoveries. This scientist is presenting a paper to the American Chemical Society.

Conducting experiments is one of the most important tools in developing and testing scientific theories. The Italian astronomer and physicist Galileo was one of the first scientists to recognize that systematic experimentation could help reveal the laws of nature. During the late 1500's, Galileo began performing carefully designed experiments to study the basic properties of matter in motion. By rolling balls of different weights down inclined planes, Galileo discovered that all objects fall to the ground with the same *acceleration* (rate of increase in speed), unless air resistance or some other force slows them down.

In the early 1600's, William Harvey, an English physician, used the experimental method to learn how blood circulates through the body. He made careful studies of the human pulsebeat and heartbeat and *dissected* (cut up) human and animal corpses for examination. Harvey concluded that the heart pumps blood through the arteries to all parts of the body and that the blood returns to the heart through the veins.

Forming a hypothesis requires talent, skill, and creativity. Scientists base their proposed explanations on existing information. They strive to form hypotheses that help explain, order, or unify related facts. They then use experimentation and other means to test their hypotheses.

The discovery of the planet Neptune in the mid-1800's resulted from the formation of a hypothesis. Astronomers noticed that Uranus, which they thought was the most distant planet, was not always in the position predicted for it by the laws of gravitation and motion. Some astronomers concluded that the laws did not hold at such great distances from the sun. But other astronomers hypothesized that the force of gravity from an unknown planet might cause the variations in the orbit of Uranus. By calculating where such a planet would have to be located to affect the orbit, astronomers eventually discovered Neptune.

Expressing findings mathematically can yield valuable insights about how the world works. Galileo used mathematics to express the results of his experiments with falling bodies and to enable him to determine the distance an object would fall in a certain amount of time. The English scientist Sir Isaac Newton developed a mathematical theory of gravitation in the 1600's that explained many types of motion, both on the earth and throughout the universe. In the early 1900's, the German-born physicist Albert Einstein found that mass is related to energy by the mathematical equation $E = mc^2$. The equation states that *energy* (E) is equivalent to *mass* (m) multiplied by the *speed of light squared* (c^2). This equation later provided the basis for the development of nuclear energy.

Modeling with computers helps scientists quickly analyze large amounts of data. A *model* is a set of mathematical equations that describes the relationships between data. In the past, scientists computed these equations on paper or with a calculator. Many models were too difficult or time consuming to attempt. But the development of highly powerful computers in the late 1970's enabled scientists to formulate complex models at great speeds. Using computer models, scientists can easily vary data to test scientific hypotheses. They can also perform experiments that would be impossible in a laboratory.

Some computer models are *simulations* (images) of realistic situations or objects. For example, meteorologists may create a simulation of a thunderstorm that shows cloud movement and changes in atmospheric pressure. An engineer may simulate an airplane's flight to find ways of improving its design. Computer models are also used to predict voting results, population growth, and stock market prices.

How scientists communicate

Scientific knowledge spreads quickly when people exchange new ideas. Scientists can improve their hypotheses based on the advice of other experts, and unique hypotheses can stimulate further research and discovery.

Science networks. Scientists depend on informal and formal networks to communicate their ideas. They may informally talk about their experiments with other scientists, who in turn pass on the information. Informal newsletters, computer networks, electronic journals, facsimile (fax) machines, and even the telephone help scientists spread the latest news.

Scientists may also use teaching as an informal way to exchange ideas. For example, university professors can try out hypotheses on experienced students. Scientists often teach their theories to a wide audience through newspapers, magazines, and radio and TV programs.

Science publications. Special magazines known as *scientific journals* enable scientists to announce formally the results of their work. Most scientific journals carry technical articles concerning research in one par-

ticular field. They are circulated to individuals working in that field. Journal editors receive many articles reporting discoveries, and they select for publication only those that reflect careful research. Some editors send articles to a *peer review board* of experts who help decide if articles should be published.

Scientists also rely on reference publications known as *indexes, abstracts,* and *digests.* Indexes list the vast number of scientific books and articles published each year. Abstracts and digests contain summaries of such material. Indexes, abstracts, and digests are available in printed form—either through mailings to subscribers or through library reference departments—and in computer databases.

Scientific gatherings provide scientists with a formal place to discuss the latest discoveries and to meet other experts in their field. Scientists participate in gatherings of local clubs, national meetings, and international conventions. They also share information as they work together at research institutes, which are set up by professional societies, businesses, and governments. Some countries jointly sponsor research institutes as a way of sharing the cost of expensive laboratory equipment. Scientists come from around the world to work and study at these laboratories. See **CERN; Institute for Advanced Study; National Institutes of Health.**

The history of science

From earliest times, people have been curious about the world around them. Thousands of years before civilization began, people learned to count and tried to explain the rising and setting of the sun and the phases of the moon. They studied the habits of the animals they hunted, learned that some plants could be used as drugs, and acquired other basic knowledge about nature. These achievements marked the beginnings of science. They were among the first attempts to understand and control nature. In general, mathematics and medicine were the first sciences to develop, followed by the physical sciences, life sciences, and social sciences.

Early civilizations. The sciences developed by the peoples of the first civilizations dealt chiefly with practical matters. For example, mathematics was used for basic business and government transactions. Astronomy provided the basis for keeping time and determining when to plant and harvest crops. As early as 3000 B.C., the Egyptians studied the heavens to forecast the arrival of the seasons and to predict when the annual flooding of the Nile River would occur. The Egyptians used geometry to establish property lines and to make the measurements needed to build huge pyramids. They also learned some anatomy, physiology, and surgery through embalming their dead.

In ancient Babylonia, the people used a system of counting in units of 60, which is the basis of the 360-degree circle and the 60-minute hour. They understood fractions, squares, and square roots. They also developed complicated mathematical models of the motions of the planets and other heavenly bodies. Their detailed observations of the sky enabled them to predict solar and lunar eclipses and other astronomical events.

The Chinese and Indian civilizations developed a little later than the Egyptian and Babylonian cultures. By the 300's B.C., the Chinese had mapped the major stars in the heavens and, like the Babylonians, succeeded in predicting eclipses. The ancient Chinese had their own system of mathematics. They also developed acupuncture and other medical practices that have been handed down almost unchanged to the present. Medicine in ancient India dealt with the prevention as well as the treatment of illness. Indian surgeons performed many kinds of operations, including amputations and plastic surgery. Early Indian mathematicians invented the Hindu-Arabic numerals that we use today.

The earliest advanced cultures in the Americas also had a working knowledge of astronomy and mathematics. One of the first major civilizations was that of the Olmec Indians of Mexico, who developed a counting system and a calendar between 1200 and 100 B.C. By about A.D. 250, the Maya of Central America and Mexico were studying the motions of the sun, moon, stars, and planets from observatories. They used their astronomical knowledge to develop religious and civil calendars. The Maya also had an advanced mathematical system. During the 1400's, the Aztec Indians of Mexico and the Inca Indians of Peru ruled powerful empires. Carvings on a famous "Calendar Stone" left behind by the Aztec represent the regular motions of the heavenly bodies, as well as religious symbols and symbols for the days of the month. The Inca used mathematics in constructing buildings and roads.

Ancient Greece. The Greeks left the greatest scientific heritage of all the ancient peoples. The Greeks stressed the development of general theories about the workings of the world. The Greeks were the first to begin a systematic separation of scientific ideas from superstition.

About 400 B.C., a Greek physician named Hippocrates taught that diseases have natural causes and that the body can repair itself. He was the first physician known to consider medicine as a science apart from religion. During the 300's B.C., Aristotle, one of the greatest Greek philosophers, studied many areas of science. Aristotle gathered vast amounts of information about the variety, structure, and behavior of animals and plants. He showed the need for classifying knowledge and recognized the importance of observation. He also developed deductive logic as a means of reaching conclusions.

Greek mathematics was more advanced than that of any other ancient culture. The Greeks became the first people to separate mathematics from purely practical uses and to develop systematic methods of reasoning to prove the truth of mathematical statements. By 300 B.C., Thales, Pythagoras, Euclid, and other Greek mathematicians had perfected geometry as a single logical system. The Greeks believed that the study of mathematics could yield absolutely certain and eternal knowledge. For example, once a principle of geometry was proved, it remained true for all time.

Some Greek scientists had an interest in practical affairs. During the 200's B.C., for instance, the Greek mathematician and inventor Archimedes invented the compound pulley. The pulley made possible the construction of machines that could easily move heavy loads.

The Greeks mapped the stars and measured the size of the earth with surprising accuracy. The astronomers used the circle, which they considered the perfect math-

ematical form, as their model for the heavens. They worked out various mathematical models and mechanical systems that explained the motions of the planets in terms of circular paths. In the A.D. 100's, Ptolemy, one of the greatest astronomers of ancient times, presented his ideas and summarized those of earlier Greek astronomers in the *Almagest*. In this work, Ptolemy stated that the sun and the planets moved around the earth in circular orbits. Astronomers accepted versions of Ptolemy's *geocentric* (earth-centered) theory of the universe for more than 1,400 years.

Although the ancient Greeks made many important scientific advances, their approach to science had limitations. Believing mathematics to be eternally true, unchanging knowledge, the Greeks never saw that it could be used to analyze the physics of motion and other constantly changing properties of nature. Nor did the Greeks discover the importance of testing their observations systematically. Many of their conclusions were false because they were founded on "common sense" instead of experiments. For example, Aristotle mistakenly thought, on the basis of common sense, that heavier objects fall to the earth faster than lighter ones.

Ancient Rome. By the A.D. 100's, the city of Rome had conquered much of the known world, including the areas of Greek civilization. The Romans were excellent architects, engineers, and builders. But they contributed little to theoretical science. Under Roman rule, scholars continued to accept the scientific knowledge of the Greeks. Many Roman physicians came from the Greek-speaking world, and the Romans employed Greek tutors or sent their children to Athens and other centers of Greek learning for advanced education.

Although the Romans themselves made few scientific discoveries, vast encyclopedias of scientific knowledge were written under Roman rule. In a 37-volume work called *Natural History*, the Roman author Pliny the Elder gathered the scientific learning of his day. A Greek geographer and historian named Strabo described all parts of the known world in his 17-volume *Geography*.

The Greek physician Galen, who practiced medicine in Rome during the A.D. 100's, developed the first medical theories based on scientific experiments. Galen dissected animal corpses for study and greatly advanced the knowledge of anatomy. However, he had many false notions about how the human body works.

The Middle Ages was a 1,000-year period in European history that began in the A.D. 400's. For hundreds of years after this period began, little scientific investigation took place in Europe. Most scholars were more interested in *theology*, the study of God, than in the study of nature. They relied on Greek and Roman writings for scientific information and saw no need to make observations of their own. Aristotle, Euclid, Galen, and Ptolemy were considered the authorities on science. But many of the ancient works used by European scholars of the Middle Ages were poorly preserved. Errors were introduced as copies were made, and the contents of the works were often inaccurately summarized.

Meanwhile, Arabs in the Middle East preserved much of the science of ancient Greece and Rome. They carefully translated many Greek and Roman texts into Arabic. Through their conquests, they came into contact with Persian astronomy, history, and medicine and with the Indian system of numbers and decimal numeral system.

Arabic scientists also made important contributions of their own in astronomy, mathematics, medicine, optics, and other sciences. An Arab mathematician named al-Khowarizmi organized and expanded algebra in the early 800's. Avicenna, an Arab physician of the late 900's and early 1000's, produced a vast medical encyclopedia titled the *Canon of Medicine*. It summed up the medical knowledge of the day and accurately described meningitis, tetanus, and many other diseases. During the early 1000's, the Arab physicist Ibn al-Haytham, also known as Alhazen, recognized that vision is caused by the reflection of light from objects into our eyes. In spite of their many scientific achievements, the Arabs did not use experimental methods or develop the instruments or applied mathematical techniques that were necessary to the development of modern science.

During the 1000's, European scholars began to show a renewed interest in science. Many major Arabic scientific works were introduced into Europe and translated into Latin, the language of learning in the West. The Hindu-Arabic number system also spread to Europe, where it stimulated the development of mathematics and began to be used in business. Some theologians of the 1100's and 1200's, such as Peter Abelard of France and Thomas Aquinas of Italy, started systematic efforts to bring Christian teachings into harmony with rediscovered scientific ideas. During the 1100's, the first European universities were established. In time, universities were to play a vital role in the growth of science.

Relatively few medical advances occurred in Europe during the Middle Ages. Physicians relied on the teachings of Galen, rather than make new discoveries based on their own observations and studies. Epidemics frequently swept across Europe. From 1347 to 1352, for example, a terrible epidemic of plague, now known as the Black Death, killed about a fourth of Europe's population. To treat or prevent diseases, many people continued to depend on magic and superstition.

The rebirth of science in Europe began in 1543 with the publication of two books that broke scientific tradition. One book was written by the Polish astronomer Nicolaus Copernicus, and the second by Andreas Vesalius, an anatomist born in what is now Belgium.

Copernicus' book, called *On the Revolutions of the Heavenly Spheres*, challenged Ptolemy's view that the earth was the center of the universe. Ptolemy's geocentric theory required a complicated series of circular motions to account for astronomers' observations of how the planets appeared to move. Copernicus realized that if the earth and other planets traveled around the sun, a less complicated arrangement of circles could explain the observed motions of the planets. But his *heliocentric* (sun-centered) theory still did not accurately predict the motions of all the planets.

During the 1500's, a Danish astronomer named Tycho Brahe observed the motions of the planets far more precisely than they had ever been observed before. Brahe's work enabled Johannes Kepler, a German astronomer and mathematician, to lend new support to the heliocentric theory in 1609. Kepler used intricate calculations to show that the theory could explain the movements of the planets if the planets orbited the sun in *elliptical* (oval) paths rather than circular ones. The elliptical

shape of the orbits would also make it easier to account for the movements of the planets. Kepler's work marked the start of modern astronomy.

The second tradition-breaking book published in 1543 was Vesalius' *On the Structure of the Human Body.* In this work, Vesalius laid out in detail the most precise anatomical knowledge of the day. He based the book on observations he made in dissecting human corpses. His book gradually replaced those of Galen and Avicenna.

The scientific revolution. During the late 1500's and early 1600's, scholars and scientists increasingly realized the importance of experimentation and mathematics to scientific advances. This realization helped bring about a revolution in science. The great Italian scientist Galileo stressed the need for carefully controlled experiments. In his research, Galileo used observation and mathematical analysis as he looked for cause and effect relationships among natural events. He recognized that experimentation could lead to the discovery of new principles. For example, Aristotle had taught that the heavier an object is, the faster it falls to the ground. Galileo questioned that idea. He set up experiments to find the true laws of falling bodies and proved that Aristotle was wrong. Through experimentation, Galileo discovered many basic principles of mechanics.

Galileo also saw the need to extend the range and power of the human senses with scientific instruments. He improved such instruments as the clock and telescope. With the telescope, Galileo found convincing evidence supporting Copernicus' heliocentric theory.

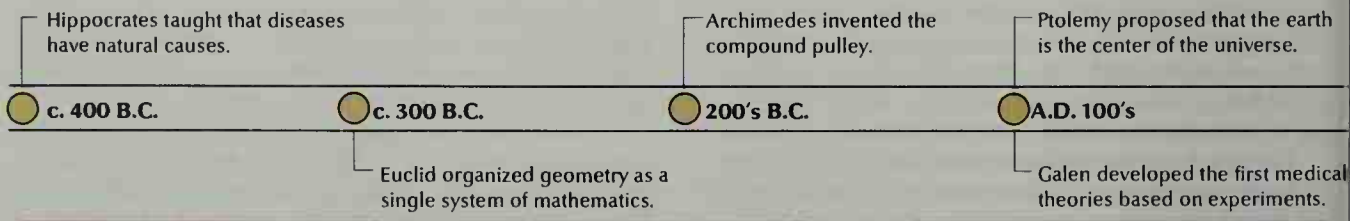
Another remarkable scientist of the 1600's was Sir Isaac Newton of England. Newton used the findings of others to develop a unified view of the forces of the universe. In his book *Principia* (1687), he formulated a law of universal gravitation and showed that both objects on the earth and the heavenly bodies obey this law. Newton's studies of lenses and prisms laid the foundation for the modern study of optics. Newton and Gottfried Wilhelm Leibniz, a German philosopher, independently developed a new system of mathematics, calculus.

The scientific revolution also extended to many other areas of science. Modern physiology began in the early 1600's with the work of William Harvey, an English physician. Harvey performed careful experiments and used simple mathematics to show how blood circulates through the human body. In the mid-1600's, an English scientist named Robert Hooke pioneered in the use of the microscope to study the fine structures of plants and animals and uncovered a new world of cells. Also in the mid-1600's, Robert Boyle, an Irish scientist, helped establish the experimental method in chemistry. Boyle introduced many new ways of identifying the chemical composition of substances.

In addition to scientific discoveries, new ideas about the philosophy and methods of science arose during the 1600's. The French philosopher René Descartes proposed that mathematics was the model all other sciences should follow. He believed mathematics yielded absolutely certain conclusions because the mathematical process started with simple, self-evident truths and then used logic to move, step by step, to other truths.

The English philosopher and statesman Francis Bacon viewed experience as the most important source of knowledge. He thought that by collecting all the observ-

Highlights in the history of science



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Egyptian geometry dealt with surveying land and other practical matters. This papyrus from the 1500's B.C. shows calculations of the area of a field.

Fresco (1510-1511); The Vatican, Rome (SCALA/Art Resource)

Aristotle, *right,* the great Greek philosopher, studied many areas of science in the 300's B.C. He emphasized careful observation in his scientific studies.

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Arab astronomers of the A.D. 800's and 900's mapped the heavenly bodies. The Arabs also made major advances in mathematics, medicine, and optics.

able facts of nature, a person could discover the laws which govern the universe. In his book *New Atlantis* (1627), Bacon described a research institution equipped with many tools of modern science, including laboratories, libraries, and printing presses. Bacon's ideas inspired the creation of the Royal Society in London in 1660 and of the Academy of Sciences in Paris in 1666. These societies were among the first institutions whose chief aim was to promote science.

Some theologians of the 1600's supported science because they believed that it helped reveal the wonders of God's creation. They also felt that scientific discoveries could be used to improve the quality of human life. But many other theologians were deeply upset by the development of scientific laws that seemed to govern the physical world without divine assistance. They opposed the heliocentric theory and condemned other scientific ideas that they believed contradicted traditional beliefs about human beings and their place in the universe.

The Age of Reason, also called the *Enlightenment,* was a philosophical movement that greatly affected the development of science during the late 1600's and the 1700's. The leaders of the movement insisted that the use of reason was the best way to determine truth. They felt that everything in the universe behaved according to a few simple laws, which could be expressed mathematically. The philosophers of the Age of Reason developed many rules of scientific study that are still used.

Great efforts were made during the Age of Reason to circulate the results of the scientific research of the times. Many scholars gathered, organized, and published this knowledge. The most famous reference work was the 28-volume *Encyclopédie* (1751-1772) edited by two French authors, Denis Diderot and Jean d'Alembert. The *Encyclopédie* contained reports on much of the science and technology of the day. See **Age of Reason.**

One of the major scientific achievements of the 1700's was the creation of modern chemistry. Scientists developed the techniques necessary for isolating and studying gases in their pure forms. They discovered many chemical substances, including chlorine, hydrogen, and carbon dioxide. Oxygen was discovered by the Swedish chemist Carl Scheele in the early 1770's and independently by the English chemist Joseph Priestley in 1774. By 1777, Antoine Lavoisier of France had discovered the nature of *combustion* (burning). He showed that combustion results from the rapid union of the burning material with oxygen. Lavoisier also developed the law of the conservation of matter. This law stated that matter cannot be created or destroyed but only chemically changed in form. Lavoisier also helped work out the present-day system of chemical names.

Major advances occurred in biology during the 1700's. A Swedish naturalist and botanist named Carolus Linnaeus devised a systematic method for naming and classifying plants and animals in the mid-1700's. His method, with many alterations, is still used. Two French naturalists, Comte de Buffon and Georges Cuvier, made great advances in the study of fossils and of comparative anatomy and did much to prepare the way for the scientific investigation of evolution.

In 1776, the Scottish economist Adam Smith published *The Wealth of Nations,* the earliest formulation of classical economics. The first systematic studies

Leonardo da Vinci studied anatomy, astronomy, botany, and geology.

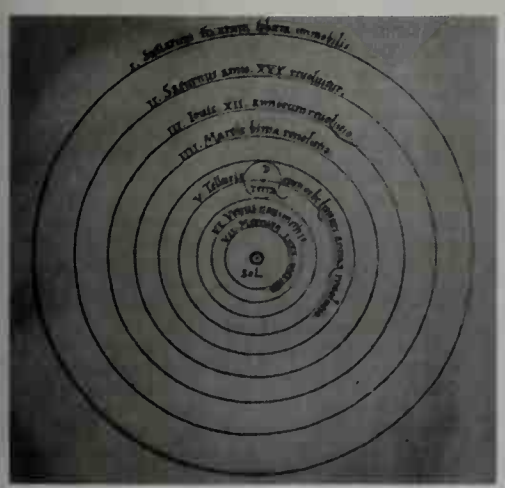
c. 1500

1609

Johannes Kepler established astronomy as an exact science.

William Harvey published his theory of how the blood circulates.

1628



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The sun-centered theory is shown in this diagram from *On the Revolutions of the Heavenly Spheres* (1543) by Nicolaus Copernicus of Poland. His work revolutionized astronomy.

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Andreas Vesalius wrote the first scientific text on human anatomy. His book, *On the Structure of the Human Body,* appeared in 1543.

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A pendulum clock from 1641 was designed by Galileo, who saw the need for precise scientific instruments.

of electricity were conducted during the 1700's. In the American Colonies, Benjamin Franklin proved in 1752 that lightning is electricity when he performed his famous experiment with a flying kite during a thunderstorm. In the late 1700's, two Italian scientists, Luigi Galvani and Count Alessandro Volta, made some of the first experiments with electric current.

Scientific advances of the 1800's. Scientific expeditions traveled to all parts of the world during the 1800's. Their purpose was to expand geographical knowledge and to study the plants and animals they found. From 1831 to 1836, Charles Darwin worked as a naturalist with a British expedition aboard the H.M.S. *Beagle*. The *Beagle* visited places throughout the world, and Darwin studied plants and animals everywhere it went. While on the voyage, Darwin read the works of a British geologist named Charles Lyell. Lyell believed that the earth had been changed slowly and gradually by natural processes over long periods of time. Darwin began to wonder whether life on the earth had also evolved through natural processes.

Darwin set forth his theories of evolution in *The Origin of Species* (1859). In this book, Darwin gave abundant evidence that plants and animals had changed their characteristics through the ages. He explained how these changes might have occurred through *natural selection*. In this process, the organisms best suited to their environment are the ones most likely to survive and leave descendants. Darwin's ideas helped explain the basic similarities—or unity—among all living organisms because they evolved from common ancestors. The theory of evolution became one of the most intensely debated scientific issues of the late 1800's. The theory aroused especially fiery opposition among religious leaders who believed that it conflicted with the Biblical account of the Creation. See **Evolution**.

Another important unifying idea in the biological sciences was the theory that all living things are made up of cells. The theory was proposed by two German scientists, Matthias Schleiden and Theodor Schwann, in the 1830's. Their idea had been influenced by a German philosophical movement called *Naturphilosophie*. This movement emphasized the unity of all things in nature and of all forces in the universe.

Physical scientists of the 1800's also tried to produce a unified, complete view of the laws of nature. The Russian chemist Dmitri Mendeleev helped systematize the study of chemistry when he published his periodic table in 1869. In the 1840's, James P. Joule, an English physicist, showed that heat is a form of energy. He was also one of several scientists to advance the law of the conservation of energy. This law states that energy cannot be created or destroyed but only changed in form.

The physicists Michael Faraday of England and Joseph Henry of the United States found independently in the early 1830's that a moving magnet can produce an electric current. In the 1860's, James Clerk Maxwell, a Scottish mathematician and physicist, worked out the mathematical equations for the laws of electricity and magnetism. His electromagnetic theory stated that visible light consists of waves of electric and magnetic forces. It also proposed the existence of invisible waves made of the same forces. In the late 1880's, Heinrich Hertz, a German physicist, produced electromagnetic waves that fitted Maxwell's theory. His work led to the development of radio, radar, and television.

During the late 1800's, several important scientific discoveries began to reveal a new picture of the physical

Robert Hooke used the microscope to uncover the world of cells.

Adam Smith published the first complete work on classical economics.

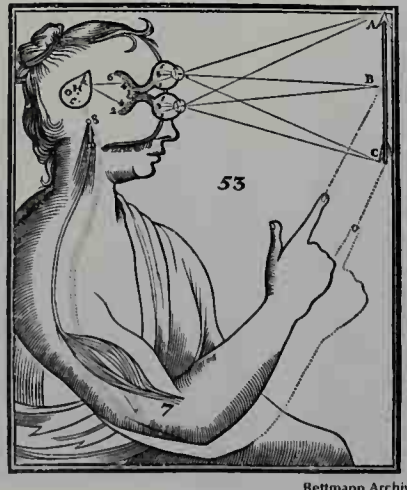
Mid-1600's — **1770's** — **1776**

Robert Boyle helped establish the experimental method in chemistry.

Carl Scheele and Joseph Priestley independently discovered oxygen.

Mary Evans Picture Library

Experiments with prisms conducted in the 1600's by Sir Isaac Newton of England began the modern study of optics. Newton demonstrated that sunlight is a mixture of light of all colors.



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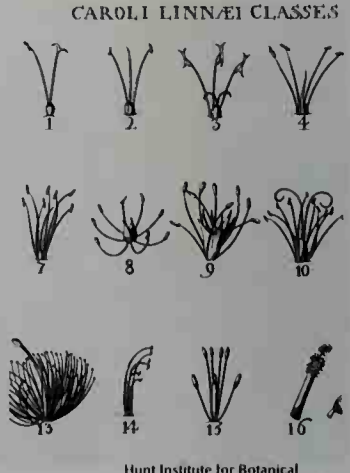
Human vision was explained in geometric terms by René Descartes, a French philosopher of the 1600's. He held that mathematics was a model for all sciences.



Hunt Institute for Botanical Documentation, Carnegie-Mellon University

Scientific classification of plants and animals was begun by Carolus Linnaeus of Sweden in the 1700's.

universe. In the 1700's, the idea that matter consists of small particles that cannot be divided began to gain acceptance. In 1803, an English chemist named John Dalton had used the idea of indivisible particles, or atoms, to explain the way elements combine and form compounds. But in the 1890's, the picture of atoms as solid objects began to fade. Scientists discovered electrons and natural radioactivity. These discoveries suggested that atoms have some kind of internal structure.

Several new sciences had their beginnings in the 1800's. In the 1830's, the French philosopher Auguste Comte started the study of sociology. Comte developed the theory of *positivism*, which held that social behavior and events could be observed and measured scientifically. In the mid-1800's, Gregor Mendel, an Austrian monk, discovered the basic statistical laws of heredity that laid the foundation for the science of genetics. The French chemist Louis Pasteur started modern microbiology in the mid-1800's with his studies of fermentation and disease. He found that certain microscopic organisms can produce disease in people and other animals.

Many scientists of the 1800's studied the relationship between the physiology of the nervous system and human behavior. In 1879, Wilhelm Wundt, a German philosopher, founded one of the first laboratories of experimental psychology in Leipzig, Germany. In the late 1800's and early 1900's, the Austrian physician Sigmund Freud established the field of psychoanalysis by introducing the idea that mental illness could be understood in terms of competing, unbalanced forces in the unconscious mind.

Science in the early 1900's. Revolutionary advances in physics marked the beginning of the 1900's as scientists continued to challenge existing ideas. In 1900, Max Planck, a German physicist, advanced his quantum theory to explain the spectrum of light emitted by certain heated objects (see **Quantum mechanics**). The theory states that energy is not given off continuously, but only in separate units called *quanta*.

In 1905, another German physicist, Albert Einstein, showed that light may be regarded as consisting of individual energy units. He later suggested that these units are particles, now called *photons*. That same year, Einstein published his special theory of relativity. His theory revised many of the ideas of Newtonian physics and offered scientists new ways of thinking about space and time. See **Relativity**.

Research into the structure of the atom expanded rapidly. In 1911, the British physicist Ernest Rutherford theorized that the mass of an atom is concentrated in a tiny nucleus, which is surrounded by electrons traveling at tremendous speeds. But his theory did not deal with the arrangement of electrons. In 1913, a description of electron structure was proposed by Niels Bohr, a Danish physicist. Bohr suggested that electrons could travel only in a set of definite orbits around the nucleus.

Bohr's original picture of the atom soon proved to be inadequate, though many of the ideas behind it were correct. By 1928, a complete description of the arrangement of electrons had been obtained with the help of other physicists, especially Erwin Schrödinger and Wolfgang Pauli of Austria, Paul Dirac of England, and Max Born and Werner Heisenberg of Germany. The discovery of the neutron and other atomic particles followed this early work. Chemists used the new information about atoms to improve their ideas about chemical bonds. They produced many new compounds and developed a variety of plastics and synthetic fibers.

Antoine Lavoisier discovered the nature of combustion. — 1777

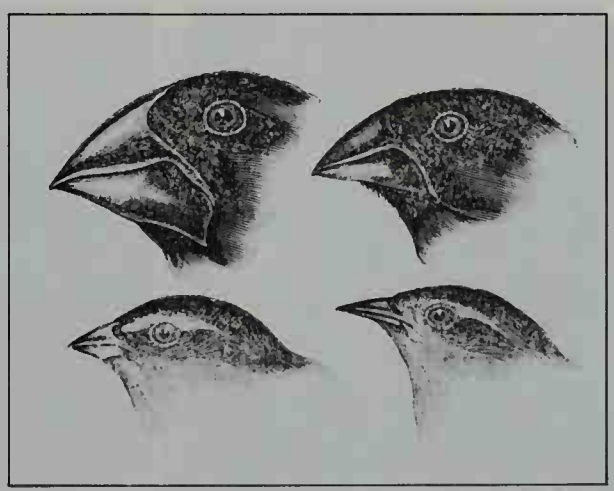
1830 — Charles Lyell showed that the earth has changed slowly through the ages.

James Clerk Maxwell developed his electromagnetic theory. — 1860's

Bettmann Archive

Michael Faraday, shown in his laboratory at the Royal Institution in London, produced a current with a moving magnet in 1831.

Drawings of cells by Theodor Schwann of Germany in the 1830's helped prove cells make up all organisms.



Granger Collection

Beak adaptations in finches on the Galapagos Islands were noted by the British naturalist Charles Darwin. Darwin used such species variations to support his theories of evolution, which he set forth in *The Origin of Species* (1859).

Great progress was also made by social scientists of the early 1900's, as they began to rely more heavily on statistical analysis and scientific research methods. In the biological sciences, a number of physician-scientists showed the importance of vitamins in the human diet. Their achievements helped conquer such nutritional diseases as beriberi and scurvy. The German physician and chemist Paul Ehrlich founded the field of chemotherapy, in which diseases are treated with chemicals. In 1928, Alexander Fleming, a British bacteriologist, discovered penicillin, the first of many antibiotics.

The work of numerous scientists began to establish the importance of genetics as a separate branch of biology. About 1901, a Dutch scientist named Hugo de Vries extensively described *mutations*—changes in hereditary material of cells. About 1910, Thomas Hunt Morgan, an American biologist, and his associates proved that *genes* are the units of heredity and that genes are arranged in an exact order along the length of cell structures called *chromosomes*. Morgan mapped the location of genes on the chromosomes of fruit flies and identified the genes responsible for such specific traits as eye color and wing shape. In the mid-1920's, an American geneticist named Hermann J. Muller discovered that mutations could be produced by treating an organism with X rays.

Achievements of the mid-1900's. Science continued to make great strides in all fields during the mid-1900's. One of the most important breakthroughs in nuclear physics occurred in the late 1930's, when Otto Hahn and Fritz Strassmann of Germany and Lise Meitner and Otto Frisch of Austria discovered the possibility of releasing energy by splitting atoms of uranium. The Italian-born physicist Enrico Fermi and his co-workers achieved the first controlled nuclear chain reaction in 1942 at the University of Chicago. Intensive research during World War II (1939-1945) led to the use of nuclear energy in weapons.

Physicists discovered new elementary particles in the mid-1900's. They also established the existence of *antiparticles*, which have electric charges or other properties that are the reverse of ordinary atomic particles (see **Antimatter**). Chemists expanded the periodic table through the creation of new radioactive elements (see **Transuranium element**). Anthropologists made new discoveries about the distant past of human beings. Geologists explained many of the changes that occur in the earth's crust with their theory of *plate tectonics* (see **Plate tectonics**). Medical science developed the Salk and Sabin polio vaccines and introduced organ and tissue transplants and other new surgical techniques. Two biologists, James D. Watson of the United States and Francis H. C. Crick of Britain, proposed a model of the molecular structure of *deoxyribonucleic acid* (DNA), the substance that carries genetic information.

The space age began in 1957, when the Soviet Union launched the first artificial satellite to circle the earth. In 1969, two U.S. astronauts became the first human beings to walk on the moon (see **Space exploration**). Astronomers also greatly expanded their knowledge of the size, structure, and history of the universe with the use of radio telescopes to collect and measure radio waves given off by objects in space. Using radio telescopes, astronomers discovered *pulsars*, *quasars*, and other previously unknown objects in space (see **Pulsar**; **Quasar**). Radio astronomers also found evidence to support the theory that the universe began with an explosion called the *big bang* (see **Cosmology** [Radio waves in space]).

Dmitri Mendeleev published his periodic table of the elements.

Marie and Pierre Curie discovered the element radium.

Sigmund Freud established th field of psychoanalysis.

1869 **1879** **1898** **c. 1900**

Wilhelm Wundt founded one of the first psychology laboratories.

Paul Ehrlich originated the tre ment of diseases with chemic

Bettmann Archive

Gregor Mendel, an Austrian monk, discovered the basic laws of heredity in the mid-1800's. He studied the inheritance of various traits in garden pea plants.

Granger Collection

Louis Pasteur of France started modern microbiology in the mid-1800's with his discovery that certain kinds of microscopic organisms cause disease.

Granger Collection

Max Planck, a German physicist, advanced his quantum theory in 1900. The theory states that energy is given off in a stream of separate units called *quanta*.

Science also made important contributions to technology during the mid-1900's. Physicists invented the transistor, which revolutionized the electronics industry and enabled manufacturers to produce portable battery-powered radios and TV sets, pocket-sized calculators, and high-speed computers. Similarly, the invention of lasers promised great advances in communications, electronics, and medicine (see **Laser**).

Recent developments. In the late 1900's, science began to advance more rapidly than ever before. This progress was reflected not only by the many discoveries made each year but also by the thousands of scientists involved in research and by the vast sums of money spent on scientific work. As the number of scientists grew, cooperation and communication among them became increasingly important. Many recent achievements resulted from scientists working in research teams. Hundreds of scientific journals, professional societies, and computerized information systems made it possible for scientists to exchange information quickly and easily.

Increasingly powerful and advanced equipment helped scientists in many different fields. For example, improvements in computers enabled mathematicians to solve problems at previously unheard of speeds. Computer simulations helped scientists perform experiments and test their theories. *Particle accelerators*, which speed up the movement of the particles that make up atoms, enabled physicists to create and study *quarks* and other basic units of matter (see **Particle accelerator**; **Quark**). *Magnetic resonance imaging (MRI)* and other advanced techniques produced images of tissues inside the body and helped identify certain diseases and injuries (see **Magnetic resonance imaging**). New telescopes, satellites, orbiting observatories, and space probes provided astronomers with information about distant reaches of the universe.

A process called *genetic engineering* became a valuable tool in genetics research. In this process, an organism's hereditary makeup is altered. Geneticists have engineered bacteria to produce human *insulin*, a hormone that is used in the treatment of diabetes. See **Genetic engineering**.

The science of today and tomorrow promises to continue to improve our understanding of the universe and to give us ever greater control over nature. But at the same time, serious debates have arisen over such science-related issues as whether it is moral to interfere in the genetic makeup of human beings or to use lasers for destructive purposes. In the future, scientists and nonscientists alike will have an increasing responsibility to ensure that the best possible uses are made of knowledge from scientific research.

Joseph W. Dauben

Related articles in *World Book* include:

Mathematics and logic

Algebra	Logic	
Calculus	Mathematics	
Chaos	Probability	
Econometrics	Set theory	
Geometry	Statistics	

The physical sciences

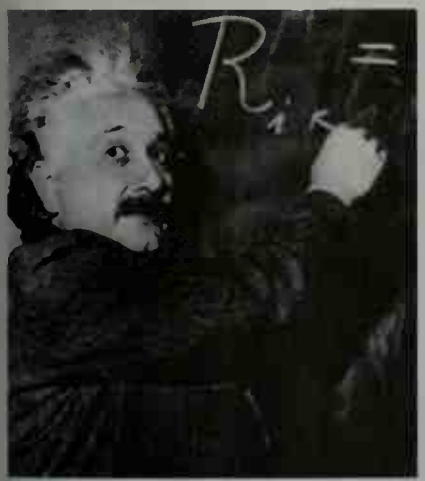
Acoustics	Electrochemistry	Optics
Aerodynamics	Electronics	Physical chemistry
Astronomy	Geochemistry	Physics
Astrophysics	Geology	Radiochemistry
Chemistry	Geophysics	Solid-state physics
Cosmology	Mechanics	Statics
Cryogenics	Meteorology	Thermodynamics
Dynamics	Nuclear physics	

Ernest Rutherford put forth his theory of atomic structure. — **1911**

1928 — Alexander Fleming discovered penicillin, the first antibiotic.

Jonas Salk produced the first effective polio vaccine. — **1953**

1957 — The Soviet Union launched the first artificial satellite.



Granger Collection

Albert Einstein, a German-born physicist, revolutionized scientific thinking about space and time with his special theory of relativity, published in 1905.

Historical Pictures Service

Enrico Fermi and others at the University of Chicago achieved the first controlled nuclear chain reaction in 1942, starting the atomic age.

© Bar-Brown, Camera Press Ltd.

A ladderlike model of DNA, the substance that controls heredity, was built by James Watson of the United States, *left*, and Francis Crick of England, *right*, in 1953.

The life sciences

Anatomy
Bacteriology
Biochemistry
Biology
Biophysics
Botany
Classification, Scientific
Cryobiology
Ecology
Embryology
Exobiology
Genetic engineering
Genetics
Gnotobiotics
Histology
Marine biology
Medicine
Microbiology
Molecular biology
Morphology
Nutrition
Paleontology
Pharmacology
Physiology
Sociobiology
Zoology

The social sciences

Anthropology
Archaeology
Criminology
Economics
Geography
History
Linguistics
Philosophy
Political science
Psychology
Social science
Sociology

Biographies

World Book has hundreds of biographies of scientists. See the lists of *Related articles* with specific articles on the major branches of science, such as **Biology** and **Physics**.

Organizations

American Association for the Advancement of Science
Arts and Sciences, American Academy of
International Council of Scientific Unions
Max Planck Society for the Advancement of Science
National Academy of Sciences
National Research Council
Royal Institution
Royal Society

Other related articles

Careers
Science projects
Technology

Outline

I. The importance of science
A. To everyday life
B. To philosophical thought
II. The branches of science
A. Mathematics and logic
B. The physical sciences
C. The life sciences
D. The social sciences
III. How scientists work
A. Observing nature
B. Classifying data
C. Using logic
D. Conducting experiments
E. Forming a hypothesis
F. Expressing findings mathematically
G. Modeling with computers
IV. How scientists communicate
A. Science networks
B. Science publications
C. Scientific gatherings
V. The history of science

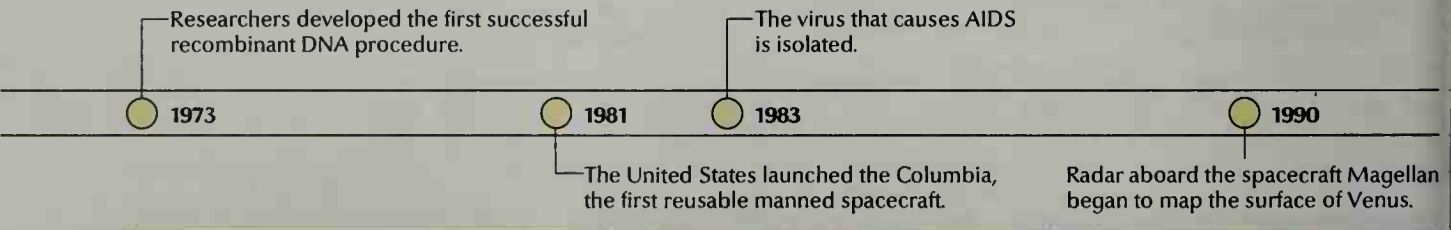
Questions

What is an *interdisciplinary* science?
What are some methods scientists use in making discoveries and developing theories?
Who was one of the first scientists to recognize that systematic experimentation could help reveal the laws of nature?
How have modern science and technology changed our lives?
Why are mathematics and logic essential tools in almost all scientific study?
What people preserved much of the science of ancient Greece and Rome during the Middle Ages?
What characteristics set science apart from other areas of knowledge, such as art, history, or philosophy?
How do scientific journal editors decide if articles that report discoveries should be published?
What were the limitations of Greek science?
What marked the rebirth of science in Europe in 1543?

Additional resources

Level I

Reeves, Diane L. *Career Ideas for Kids Who Like Science.* Facts on File, 1998.
Ronan, Colin A. *Science Explained.* 1993. Reprint. Henry Holt, 1996.
Taylor, Charles, and Pople, Stephen. *The Oxford Children's Book of Science.* Oxford, 1996.



NASA

Space exploration began to open new frontiers of scientific research during the 1960's. In 1969, astronauts of the U.S. Apollo 11 mission became the first human beings to walk on the moon.

Fermilab

Tracks made by atomic particles from a *particle accelerator,* a device that speeds up the particles, enable physicists to study the most basic units of matter.

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Genetic engineering, which is used to alter an organism's genetic makeup, may one day help in treating hereditary diseases.

Level II
McGrath, Kimberley A., and Blachford, Stacey, eds. *The Gale Encyclopedia of Science.* 2nd ed. Gale Group, 2000.
Piel, Gerard. *The Age of Science: What Scientists Learned in the 20th Century.* Basic Bks., 2001.
Rossi, Paolo. *The Birth of Modern Science.* Blackwell, 2001.
Suplee, Curt. *Milestones of Science.* National Geographic Soc., 2000.

Science fiction is literature based on real or imagined developments in science or technology. The basic themes of science fiction include time travel, space travel, marvelous inventions or discoveries, life in other worlds, and the invasion of Earth by alien beings.

Most science-fiction writers seek to convince readers that the world they have created is possible and is derived from scientific principles. Some science-fiction writers use material derived from the "hard" sciences—that is, the physical sciences, such as physics and astronomy. Others rely more on the "soft" sciences—the social sciences, such as anthropology and sociology. Some writers focus on inventing believable scientific developments, while others are more interested in exploring the social consequences of scientific change. But all science-fiction writers try to present worlds that are radically and intriguingly different from the reader's world in terms that the reader can understand.

Forerunners of science fiction. Science fiction as a distinct type of literature took shape during the 1800's. But earlier literature contains many elements of science fiction. For example, the ancient Greek epic poem the *Odyssey* is a tale of fantastic travels.

The visionary work *Utopia* (1516) by the English writer Saint Thomas More describes an ideal society, with justice and fairness for all. French author Cyrano de Bergerac's *Other Worlds* (originally two books, published in 1657 and 1662) describes trips to the moon and the sun. *Gulliver's Travels* (1726) by Jonathan Swift of England combines a fantastic voyage with social criticism. *Micromégas* (1752) by the French writer Voltaire is the first story of visitors from other planets.

The first science fiction. *Frankenstein* (1818) by Mary Shelley of England is the work often cited as the first science-fiction novel. It tells the story of a scientist who tries to create a living being for the good of humanity but instead produces a monster. In the mid-1800's, American author Edgar Allan Poe wrote a large number of stories combining science-fiction themes with tales of horror.

Two of science fiction's most important authors emerged in the last half of the 1800's. French novelist Jules Verne became the first writer to specialize in science fiction. In such novels as *Twenty Thousand Leagues Under the Sea* (1870), Verne used realistic detail and believable explanations to support incredible tales of adventure. British author H. G. Wells created some of science fiction's most enduring works. His imaginative novels and short stories also reflect his training as a scientist. With such works as *The War of the Worlds* (1898), Wells influenced much later science fiction.

The early 1900's. Many science-fiction works of the early 1900's emphasized social and political argument and other serious themes. For example, Yevgeny Zamyatin's *We* (1924) helped define a form known as *antiutopia* or *dystopia.* This type of fiction sees an ideal world as a nightmare. Czech novelist and playwright Karel Čapek introduced the term *robot* in his play *R.U.R.* (1921) and discussed an atomic bomb in his novel *Krakatit* (1924). Olaf Stapledon was one of the most important British writers of the period. His novel *Last and First Men* (1930) traces a 2-billion-year progression of humanity to its extinction on Neptune. Other dystopias that incorporate elements of science fiction include *Brave New World* (1932) by English author Aldous Huxley, *1984* (1949) by English author George Orwell, and *Fahrenheit 451* (1953) by American author Ray Bradbury.

During the 1920's and 1930's, science fiction developed differently in Britain and the United States. British science-fiction writers produced scientific romances in the tradition of Verne and Wells. Their works were published in hard cover and aimed at an adult audience. In the United States, however, the main outlet for science-fiction writers was low-cost magazines called *pulps.* The name came from the cheap wood-pulp paper on which the magazines were printed. Stories in the pulps emphasized adventures and concentrated on scientific marvels. Pulp-fiction stories were aimed primarily at adolescent readers.

The first magazine devoted exclusively to science fiction began publication in 1926. In that year, Hugo Gernsback, an immigrant to the United States from Luxembourg, founded the pulp magazine *Amazing Stories.* Gernsback encouraged his readers to write to the magazine and to one another. He fostered the development of a loosely organized group of readers that eventually produced many writers, editors, and critics of science fiction. About 1930, Gernsback became the first person to use the term *science fiction.* Today, to honor distinguished writing in the field, the World Science Fiction Convention presents annual Hugo Awards, named for Gernsback.

The Golden Age. The pulps increasingly turned from scientific marvels to social concerns after John W. Campbell, Jr., became editor of *Astounding Stories* magazine (later retitled *Astounding Science Fiction* and still later *Analog*). Campbell served as the magazine's editor from 1937 to 1971. The period from about 1937 until after World War II (1939-1945) is sometimes referred to as the *Golden Age* of science fiction.

Campbell sought stories that were believable and well written. He attracted and developed such writers as Robert A. Heinlein, Isaac Asimov, A. E. van Vogt, and Theodore Sturgeon. These writers dominated the field in the mid-1900's. Heinlein became one of the most influential science-fiction writers of the 1900's. His best-selling novel *Stranger in a Strange Land* (1961) explores controversial ideas about morality, religion, and sex. Heinlein also was important in writing science fiction for young adults, including *Rocket Ship Galileo* (1947).

Growing popularity. Science fiction began to gain a wider audience after World War II. Its popularity grew as developments in the production of nuclear energy and in space exploration showed that much science fiction was more realistic than many people had believed.

Beginning in 1950, a steadily increasing number of science-fiction novels were published in hard cover and paperback. In the mid-1970's, a renewed interest in science-fiction magazines developed. In 1977, publication began of the first successful new science-fiction magazine since the early 1950's, *Isaac Asimov's Science Fic-*

tion Magazine (later shortened to *Asimov's Science Fiction*). *Omni,* a science magazine that regularly included science-fiction stories, first appeared in 1978.

Science-fiction television programs and motion pictures attracted large audiences in the late 1900's. One of the best-known television programs was "Star Trek" (1966-1969). A series of motion pictures based on the program became extremely popular. The science-fiction movie *Star Wars* (1977) and its sequels, with their impressive special effects, set box-office records.

Science fiction became enormously popular in Russia and Japan during the middle and late 1900's. Some writers, including the brothers Arkady and Boris Strugatsky of Russia and Sakyo Komatsu of Japan, have achieved worldwide fame. The Strugatskys, whose science fiction often expresses social criticism, first gained attention with *Hard to Be a God* (1964), in which a historian from Earth becomes involved with the society of an underdeveloped planet. In Komatsu's *Japan Sinks* (1973), the island nation is in danger of crumbling into the ocean.

Stanislaw Lem of Poland has been recognized as a major science-fiction writer since the 1950's. His wide knowledge and depth of analysis are evident in such works as *Solaris* (1961), in which Earth scientists are sent to study a huge, thinking ocean on another planet.

A New Wave of science-fiction writing emerged in the 1960's and 1970's. Key authors included British writers, such as Brian Aldiss, J. G. Ballard, and Michael Moorcock, and American writers Samuel R. Delany and Roger Zelazny. Most New Wave fiction is pessimistic in tone and features antiheroes, yet also emphasizes traditional literary elements of character and style.

One outgrowth of the Golden Age was *hard science fiction,* which stresses "hard" sciences and technology, believably extending scientific developments into fiction. Notable hard science-fiction authors included American authors Jerry Pournelle and David Brin. American author Michael Crichton became a best-selling author of the *technothriller,* which stresses suspense.

Recent developments. In the late 1900's, science-fiction video games became popular. A subcategory of science fiction called *cyberpunk* emerged. Cyberpunk focuses on computer technology and involves human interaction with supercomputers. The term developed from the words *cybernetics* and *punk.* Cybernetics is the study of control systems in machines and living things. Punk comes from rock-music language of the 1970's, and it refers to an aggressive, streetwise person. One of the earliest and best-known examples of cyberpunk is *Neuromancer* (1984) by American-born author William Gibson. Other recent science fiction explored *nanotechnology,* which involves building structures up from the atomic level.

William A. Kumbier

Related articles in *World Book* include:

Science-fiction writers

Asimov, Isaac
Bradbury, Ray
Burroughs, Edgar Rice
Čapek, Karel
Clarke, Arthur C.
Crichton, Michael
Cyrano de Bergerac, Savinien de
Dick, Philip K.
Ellison, Harlan
Heinlein, Robert A.
Herbert, Frank
Huxley, Aldous
Le Guin, Ursula K.
Lessing, Doris
Lewis, C. S.
Norton, Andre
Orwell, George
Serling, Rod
Shelley, Mary W.
Stapledon, Olaf
Sturgeon, Theodore
Verne, Jules
Vonnegut, Kurt
Wells, H. G.

Other related articles

Frankenstein
Gothic novel
Gulliver's Travels
Literature for children (Fiction/fantasy and science fiction)
Lucas, George
Novel (The middle and late 1900's)
Robot
Spielberg, Steven
Utopia

Additional resources

Bleiler, Richard, ed. *Science Fiction Writers.* 2nd ed. Scribner, 1999.
Clute, John, and Nicholls, Peter. *The Encyclopedia of Science Fiction.* St. Martin's, 1993.
Roberts, Adam. *Science Fiction.* Routledge, 2000.

Science projects are systematic investigations that help students learn about nature and natural laws. Most of the great discoveries of our age came from systematic investigations conducted by scientists. Students working on a project should use methods of discovery employed by scientists. For a discussion of these methods, see **Science** (How scientists work).

A student may base his or her project on a single field of science, such as astronomy, biology, chemistry, or physics. Or the project may involve several fields. For example, a student may use biology, chemistry, and physics to complete a project on environmental pollution.

To gain the most benefit from their projects, a majority of students prepare a report and an exhibit that summarize the project and what was learned by doing it. Many schools and communities give students the opportunity to exhibit their projects at an event called a *science fair.*

Kinds of science projects are as varied as the fields of science. Within each field, projects fall into four categories: (1) building a model, (2) preparing and presenting a demonstration, (3) collecting or classifying items, and (4) performing an experiment.

Building a model can help the student understand complex machines or natural systems. For example, one student might study the parts of an internal-combustion engine and how they relate by building a model. Another student might construct a model of Jupiter and its satellites to study the orbits of the satellites.

Another kind of model shows how scientific equipment works. An example is a *hygrometer* (humidity measuring device) made from two thermometers and a milk carton (see **Humidity** [illustration]).

Preparing and conducting a demonstration helps the student study a scientific principle or law. For example, the student might demonstrate why objects appear to lose weight when they are placed under water.

Collecting or classifying items helps increase the student's awareness of nature. The student might collect and classify the various kinds of plants and animals found in a field or vacant lot.

Performing an experiment may be the most difficult, yet the most educational, type of science project. The student sets up and performs an experiment to confirm or discover certain effects of natural laws. For example, the student might investigate how light of various colors affects plant growth. The student would grow plants under different colored lights and measure their growth.

Planning and doing a science project. Students should first develop an idea for their project. Many stu-

dents develop ideas from their own interest in such fields as ecology, electronics, or medical research. Suggestions for projects appear in books and magazines devoted to science. Several *World Book* articles include ideas for science projects. See the list of *Related articles* at the end of this article.

After selecting an idea, the student may need to do some background reading in textbooks and reference books. This reading helps the student decide how to go about the project. The student should concentrate on basic ideas to avoid becoming confused by too much detail and overly complicated equipment. Teachers may have suggestions about how to proceed with the project and where to find equipment.

Preparing an exhibit. An exhibit, along with a report, helps explain the science project. Most science fair exhibits feature a poster with a brief explanation of the project printed on it. The poster may also display diagrams and charts. The student can set up equipment used for experiments to show how tests were performed. Some advanced students use slides or audio or video recordings to make their exhibits more interesting. Martin J. Gutnik

Related articles. The following articles include special *World Book* science projects:

Air	Heredity	Water
Battery	Light	Waves
Chemistry	Magnetism	Weather
Dam	Microscope	

Additional resources

Adams, Richard C., and Gardner, Robert. *Ideas for Science Projects.* Rev. ed. Watts, 1997.

Bochinski, Julianne B. *The Complete Handbook of Science Fair Projects.* Rev. ed. Wiley, 1996.

Carr, Joseph J. *The Art of Science.* HighText, 1992.

Gardner, Robert, and Kemer, Eric. *Making and Using Scientific Models.* Watts, 1993.

Holonitch, Lisa, ed. *Science Experiments and Projects Index.* Highsmith, 1994.

Keen, Dan, and Bonnet, Bob. *Science Fair Projects for the Environment.* Sterling Pub., 1995. Younger readers.

Scientific classification. See Classification, Scientific.

Scientific creationism. See Creationism.

Scientific notation is a method used in scientific work to express extremely large or small numbers. Scientific notation provides a compact way to write such numbers and shows how precisely a number is known. This method also makes it easier to perform calculations involving very large or small numbers. Scientific notation states a number as a product of a number from 1 to 10 and a *power of 10.*

Powers of 10 used for large numbers are products of one or more multiplications in which 10's are the only factors. The number of times 10 is used as a factor is called the power. For example, the number 1,000,000 equals *10 to the sixth power* because:

$$1{,}000{,}000 = 10 \times 10 \times 10 \times 10 \times 10 \times 10.$$

"Ten to the sixth power" is written 10^6. The small numeral 6, which indicates the power, is called an *exponent.* As this example shows, powers of 10 make it possible to write large numbers in a compact way.

To express a large number in scientific notation, move the decimal point to the left from the end of the number to after the first digit. Next, count the number of places that you moved the decimal point. Finally, write a multiplication sign followed by a power of 10. The exponent in the power of 10 will equal the number of places that you moved the decimal point.

For example, the average distance between the earth and the sun is about 150,000,000 kilometers. The decimal point is understood to follow the last zero but is usually not written. To change 150,000,000 into scientific notation, move the decimal point from behind the last zero to after the 1. Next, determine the exponent by counting the number of places that you moved the decimal point—in this case, eight places. Finally, write a multiplication sign followed by 10^8. Thus, 150,000,000 becomes 1.5×10^8.

Just as large numbers can be expressed in terms of powers of 10, so small numbers can be expressed in terms of powers of $\frac{1}{10}$. Because $\frac{1}{10} = 10^{-1}$, the number of times $\frac{1}{10}$ is used as a factor is indicated by a *negative power.* For example, the number 0.0001 equals *10 to the minus fourth power* because:

$$0.0001 = \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$$

"Ten to the minus fourth power" is written 10^{-4}. Thus, negative powers of 10 make it possible to write small numbers in a compact way.

To express a small number in scientific notation, move the decimal point to the right so that it follows the first number that is not a zero. Then count the number of places you moved the decimal point and write a multiplication sign followed by a negative power of 10.

For example, the diameter of a virus is about 0.000001 centimeter. To write this number in scientific notation, first move the decimal point behind the 1. Then determine the negative exponent by counting the number of places you moved the decimal point—in this case, six places. Finally, write a multiplication sign followed by 10^{-6}. Thus, 0.000001 becomes 1×10^{-6}.

The number 10 expressed as a power of 10 is simply 10^1. Thus, the number 20 can be written as 2×10^1, but scientists usually do not bother to do this. Likewise, the term 10^0 equals 1, but scientists rarely use this term.

Significant figures. Scientific notation does more than save space. It also indicates how precisely you know a number. For example, suppose you estimate that you have eaten 14,248 meals in your lifetime. With scientific notation, you can use *significant figures,* also called *significant digits,* to indicate the exactness of your answer. Significant figures are the digits to the left of the multiplication sign of a number written in scientific notation. Scientists assume that you are certain of the values of these digits but not the next one.

For example, you could express the number 14,248 as 1.4×10^4. Here you have two significant figures, the 1 and the 4. Your use of 1.4 indicates that you are sure of the value of these two numbers but doubtful about the next one. Thus, 1.4×10^4 indicates that you have eaten about 14,000 meals, but you may have eaten as few as 13,500 or as many as 14,499. If you used four significant figures and wrote your number as 1.424×10^4, you would indicate that you have eaten about 14,240 meals, but you could have eaten as few as 14,235 or as many as 14,244.

You can also use a symbol called a *plus-or-minus sign* (±) to indicate how precisely you know a number. This method is less compact but more direct than using significant figures. For example, to indicate that a number lies somewhere in the range from 14,235 through 14,245, you could write 14,240±5.

Mathematical calculations. To add or subtract numbers in scientific notation that have the same exponent, simply add or subtract the significant figures:

$$(7.5 \times 10^6) + (6.11 \times 10^6) = 13.61 \times 10^6.$$

After you complete a problem with numbers in scientific notation, you must put the answer into standard scientific notation. In standard scientific notation, the number to the left of the multiplication sign must be equal to or greater than 1 and less than 10. Also, the result of an addition or a subtraction should have no significant digit farther to the right than the last significant digit in the least precisely known number. The result of a multiplication or a division should have no more significant digits than the number of significant digits in the least precisely known number.

The above answer violates the first two rules. The number to the left of the multiplication sign, 13.61, has a digit—the last "1"—that is farther to the right than the last digit in the least precisely known number in the problem—7.5. To correct this, round off 13.61 to 13.6. Then express the number in scientific notation by dividing the left part by 10 and multiplying the right part by 10. This keeps the value of the number unchanged and puts the number in proper form: 1.36×10^7.

To add or subtract numbers with different exponents, you must first make the exponents the same. If two numbers have different exponents, multiply and divide the two parts of one of them by 10 to make the exponents the same. Then simply add or subtract the significant figures and round off, as in the following example:

$$(4.4 \times 10^4) + (3.33 \times 10^3) =$$
$$(4.4 \times 10^4) + (0.333 \times 10^4) = 4.7 \times 10^4.$$

To multiply two numbers in scientific notation, multiply their digits and add their exponents:

$$(6 \times 10^6) + (5 \times 10^3) = 30 \times 10^9 = 3 \times 10^{10}$$

To divide two numbers in scientific notation, divide their digits and subtract their exponents:

$$(8 \times 10^6) \div (4 \times 10^3) = 2 \times 10^3.$$

Jack Feinberg

Scientology, *sy uhn TAHL uh jee,* is a religious movement founded by L. Ron Hubbard, an American writer and visionary thinker. His thought combined ideas from Eastern religion and modern philosophy to form a practical system for achieving mental health and human improvement.

According to Scientology, every person is an immortal being who has been born over and over again. Although each soul has great powers, negative experiences in previous lifetimes have produced *engrams,* which are mental images that prevent the soul from using its vital force. Trained Scientologists called *auditors* try to guide people through a *clearing* process that erases engrams and allows the soul to realize its potential. Although people have a mind and a body, they are themselves spiritual beings (*thetans*). According to Scientology, as thetans rise through several levels of knowledge, they grasp the divine force that is their basic nature. Scientology's goal is to restore people to their infinite potential.

The first Scientology church was established in California in 1954. As Scientology spread, it received much criticism. For example, some people charge that the donations required for auditing and other services are excessive. They claim that Scientology is a business disguised as religion. Scientologists deny this claim. In spite of long and highly publicized controversies, this spiritual movement has attracted followers throughout the world. Henry Warner Bowden

Scipio Africanus, *SIHP ee OH AF rih KAN uhs,* **Publius Cornelius,** *PUHB lee uhs kawr NEEL yuhs* (236?-183? B.C.), was a Roman general who defeated the great Carthaginian general Hannibal in the Second Punic War (218-201 B.C.). The decisive battle took place at Zama, in northern Africa, and the Romans gave Scipio the name *Africanus* because of his victory. He was also called Scipio the Elder. See **Hannibal.**

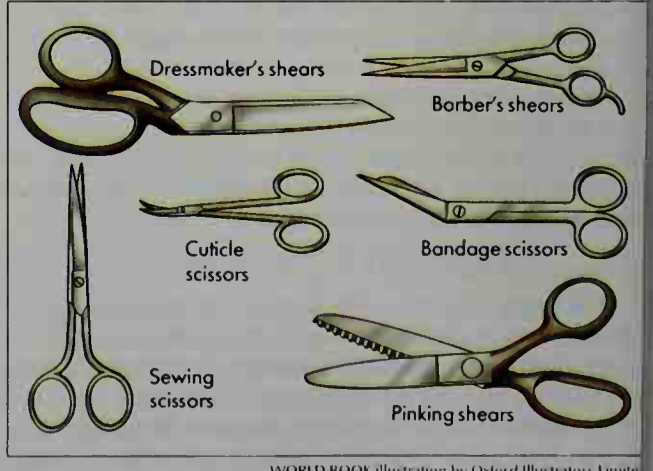
Scipio belonged to a wealthy and politically powerful family in Rome known as the Cornelii. In 199 B.C., he was elected a *censor,* an official who supervised the census and public morals. In 184 B.C., he was accused of bribery and retired from public life. Henry C. Boren

Scissorbill. See **Skimmer.**

Scissors. A pair of scissors is really two knife blades joined together to form a double lever. Each blade operates as a lever of the first class (see **Lever**). A pin or bolt holds the blades together and acts as their common *fulcrum* (support). The user squeezes the open scissors handles together to apply pressure against both sides of the material, which then is cut.

To most people, scissors and shears refer to the same instrument. But, in the hardware trade, *shears* refers to scissors with blades more than 6 inches (15 centimeters) long. The handles of scissors usually have rings of equal size. Most shears have a larger ring on one handle for the four fingers of the cutting hand. The thumb of the cutting hand fits through the other ring. Scissors and shears range in size from tiny manicuring scissors to giant, power-operated shears that cut scrap metal for steel-mill furnaces. *Pinking shears,* or *pinking scissors,*

Types of scissors



WORLD BOOK illustration by Oxford Illustrators Limited

have sawtooth edges. They are used to give cloth a scalloped edge, which keeps the material from raveling.

Scissors developed shortly after people learned how to make knives. Sharp, sturdy scissors were developed in the late 1200's. William C. Miller

Scleroderma, *sklihr uh DUR muh,* is a rare disease that causes stiffening and thickening of body tissues, particularly the skin. Most people with scleroderma have skin that gradually becomes hard, tight, and shiny.

Scleroderma may affect only the skin. In one form of scleroderma called *morphea,* round patches of hard skin form on the body. In *linear scleroderma,* a line of thickened skin forms on the arms, legs, or forehead. Linear scleroderma chiefly affects children and the elderly.

Generalized scleroderma can affect both the skin and internal body parts, including the blood vessels, kidneys, lungs, intestines, and joints. Depending on the body part affected, this form of scleroderma can cause high blood pressure, shortness of breath, difficulty in swallowing, joint pain, and muscle weakness. It occurs most often in women between the ages of 30 and 50.

Scleroderma's cause is unknown. It is not contagious and is not inherited. The bodies of affected people produce too much of a protein called *collagen.* Excess collagen causes the tissues to stiffen and thicken. Scientists think the body's immune system plays a part in causing the formation of the excess collagen. There is no known cure for scleroderma. Treatment generally involves the use of medications to control symptoms and limit collagen production. Calvin R. Brown, Jr.

Sclerosis, Multiple. See Multiple sclerosis.

Scoliosis, *skoh lee OH sihs,* is a side-to-side curve of the spine. In most cases, this condition becomes apparent during adolescence or even earlier. It affects more girls than boys, but physicians do not know why. Advanced cases can result in severe deformity that may interfere with the heart, lungs, and nervous system. Such deformity can also lead to psychological problems. Doctors do not know what causes most cases, though some result from muscular diseases or birth defects.

Many people have some form of scoliosis, but only a small percentage need medical treatment. Mild cases are simply examined regularly to make sure they do not become worse. Physicians generally prescribe a back brace and special exercises to stabilize a moderate spinal curve in young people who are still growing.

During the early 1980's, many doctors began experimenting with electrical stimulation instead of braces to stabilize moderate curves. In this procedure, a small electrical transmitter is attached nightly to electrodes taped on the surface of the patient's back or surgically implanted under the skin. The transmitter stimulates the deep back muscles and causes them to contract, pulling the spine into line.

Severe scoliosis may require surgery to straighten and *fuse* (join) the vertebrae in the area of the curve. In many cases, a steel rod is permanently attached to the spine. A body cast is worn for seven to nine months, after which most normal activities can be resumed.

In most cases, early detection and treatment eliminate the need for surgery. Many schools test all students between 10 and 15 years old for scoliosis symptoms, which include unlevel hips or shoulders, a prominent shoulder blade, or a hump on the back. James A. Hill

Scone, *skoon* or *skohn,* **Stone of,** is a stone on which the British monarchs are crowned. It lies in Edinburgh Castle in Scotland. It is also called the *Stone of Destiny.* Until 1996, the stone was kept in Westminster Abbey in London. England's King Edward I brought the stone to England from Scotland in 1296. For centuries before that, the kings of Scotland had been crowned on the stone. Scottish nationalists repossessed the stone in 1950, but it was returned to Westminster Abbey. In 1996, Queen Elizabeth II authorized return of the stone to Scotland. The stone is to be returned to London temporarily when a British monarch is crowned. Robert E. Dowse

Scopes trial was one of the most famous and controversial legal cases in United States history. The trial involved a high school teacher named John Thomas Scopes, and it took place in Dayton, Tennessee, in 1925. Scopes was found guilty of violating a Tennessee law that made it illegal to teach the theory of *evolution* in public schools. This theory suggests that human beings developed from simpler life forms over a long period. By law, public school teachers were allowed to teach only the Biblical account of the Creation, which tells how God created human beings essentially as they exist today. Many scientists accepted the view that monkeys and human beings had common ancestors, and so the Scopes case was often called the "monkey trial."

The trial attracted worldwide attention, largely because of the participation of two celebrities, William Jennings Bryan and Clarence Darrow. Bryan, an unsuccessful candidate for president of the United States three times, aided the prosecution. He believed in *fundamentalism,* a movement whose members insist that words of the Bible should be taken literally. Darrow, a famous criminal lawyer, defended Scopes. Darrow strongly supported the right to teach evolution. Bryan, considered an expert on the Bible, accepted Darrow's challenge to become a witness. But Darrow humiliated and outsmarted Bryan in the cross-examination.

Legally, the Scopes case was unimportant. Scopes

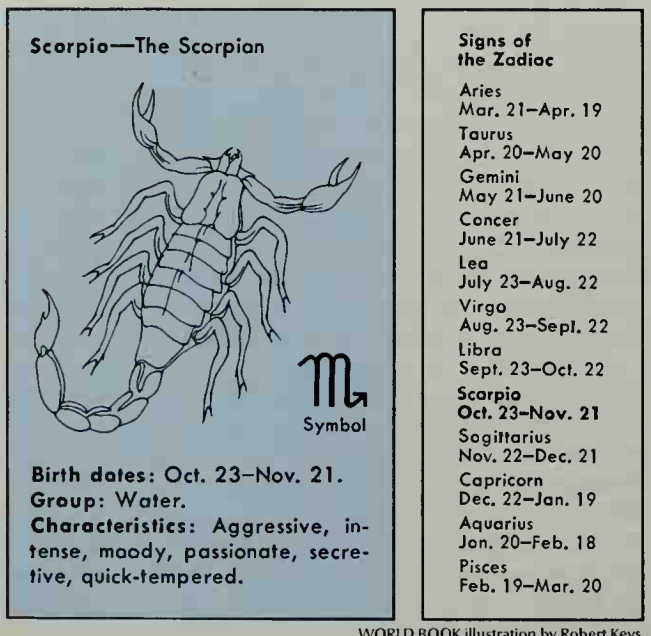
Wide World

Clarence Darrow, *left,* opposed William Jennings Bryan, *right,* during the famous Scopes trial at Dayton, Tennessee, in 1925.

was fined $100, but the conviction was later reversed because of a small legal error. The Tennessee law remained in effect until 1967, when the state legislature abolished it. Kevin Tierney

See also **Bryan, William J.; Creationism** (The 1900's); **Darrow, Clarence S.; Evolution** (Acceptance of evolution).

Scorpio, *SKAWR pee oh,* is the eighth sign of the zodiac. Its symbol is a scorpion. Astrologers believe that Scorpio is ruled by the planet Mars, which they consider a planet of force and violence. Scorpio is a water sign. Astrologers consider people born under the sign of Scorpio, from October 23 to November 21, to have the characteristics of Mars. Scorpios are aggressive and stimulated by conflict. They tend to change moods quickly, going from calm to anger and from rudeness to politeness. A fascinating personality and outstanding powers of leadership give Scorpios the respect, rather than the affection, of others. Scorpio is also ruled by Pluto, the planet of secrecy. Thus, Scorpios are secretive and like to investigate secrets. Christopher McIntosh



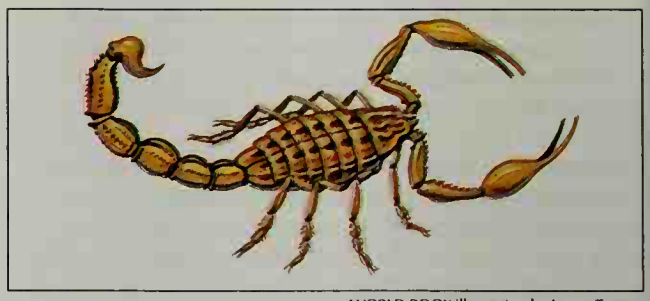
WORLD BOOK illustration by Robert Keys

See also **Astrology; Horoscope; Zodiac.**

Scorpion, *SKAWR pee uhn,* is a small animal with a potentially dangerous poisonous sting in its tail. The scorpion is not an insect. It belongs to a class of animals called *arachnids.* Spiders, mites, and ticks also belong to this class. Scorpions live in warm countries around the world. About 20 species are found in the United States. One of these lives as far north as Alberta, Canada.

A scorpion's body has two parts. Its short and thick forward part, called the *cephalothorax,* consists of the head and *thorax* (chest), which are joined together. The hind part is the long abdomen. Its last six segments form a slender tail. Most scorpions are black or yellowish and from $\frac{1}{2}$ to 8 inches (1.3 to 20 centimeters) long.

The scorpion has six pairs of jointed appendages. The first pair consists of tiny pincers. The second pair, with large claws, is used to seize and crush prey. The last four pairs are legs. There are 6 to 12 eyes—different kinds of scorpions have different numbers. The breathing pores are on the abdomen.


WORLD BOOK illustration by James Teason

The scorpion has a poisonous sting in its tail.

All mother scorpions bear live young. Scorpions eat insects and spiders, and are most active at night. Scorpions are fluorescent when exposed to ultraviolet light. The scorpion's sting is a curved organ at the end of its tail. Two glands at the base give out a poison that flows from two pores. A scorpion wound is painful but rarely causes death. Laurie J. Vitt

Scientific classification. Scorpions belong to the class Arachnida, order Scorpiones. The families of scorpions include Buthidae and Chactidae.

Scorpionfly, *SKAWR pee uhn FLY,* is an unusual insect that often has a long, pointy face. At the tip of the abdomen, the male has an enlarged body segment that curves up over the back. This segment resembles a scorpion's stinger and gives the insect its name.

The scorpionfly is about $\frac{3}{4}$ inch (20 millimeters) long. Its mouthparts are at the end of its face. It is not a true fly because it has four wings instead of two. The wings have many veins and are as long as the body. Adult scorpionflies live in woods or dense plant growth and eat chiefly insects. They lay eggs in cracks in the ground. The larvae, which resemble caterpillars, hatch in about a week and grow rapidly. They live on or in the soil and also feed on insects. Sandra J. Glover

Scientific classification. Scorpionflies make up the scorpionfly family, Panorpidae.

Scorsese, *skawr SEE zee,* **Martin** (1942-), is an American motion-picture director. Scorsese's style is strongly realistic, though he often injects personal feelings and elements of fantasy into his work. Many of his films explore an individual's capacity for violence and the sense of social isolation experienced in New York City. Scorsese also portrays the rich subculture of New York City's Italian American communities.

Scorsese's *Mean Streets* (1973) reveals the desires, friendships, and failures of youth in New York's Little Italy. *Taxi Driver* (1976) shows the world of a violence-prone war veteran. *Raging Bull* (1980) tells the story of boxing champion Jake LaMotta. *GoodFellas* (1990) and *Casino* (1995) deal with organized crime in America, drawn from real events. Scorsese also directed *The Last Temptation of Christ* (1988), a controversial portrayal of the life of Jesus. His other films include *Alice Doesn't Live Here Any More* (1974), *The King of Comedy* (1983), *After Hours* (1985), *Cape Fear* (1991), *The Age of Innocence* (1993), *Kundun* (1998), *Bringing Out the Dead* (1999), and several documentaries.

Scorsese was born in New York City. He taught filmmaking at New York University from 1963 to 1966 and from 1968 to 1970. Robert Sklar

John L. Stage, Photo Researchers

The rugged Highlands cover the northern two-thirds of Scotland. Blue lakes and steep valleys make the Highlands one of the most scenic areas in Europe.

Scotland is one of the four major political divisions that make up the United Kingdom of Great Britain and Northern Ireland. The other divisions are England, Northern Ireland, and Wales. Edinburgh is the capital of Scotland, and Glasgow is the largest city.

Scotland occupies the northern third of the island of Great Britain. Most of Scotland is mountainous. Its rugged mountains, green valleys, and deep, blue lakes provide some of the most beautiful scenery in Europe.

Most of the Scottish people live in the central part of Scotland, where there is flatter and more fertile land. Many Scots work in the service and manufacturing industries, which form the basis of the Scottish economy.

The Scottish people have long been famous for their close-knit *clans* (groups of related families), colorful plaid kilts, and skill as fierce warriors. But the clans have lost much of their importance, kilts are worn mainly for ceremonial occasions, and no war has been fought in Scotland for more than 200 years.

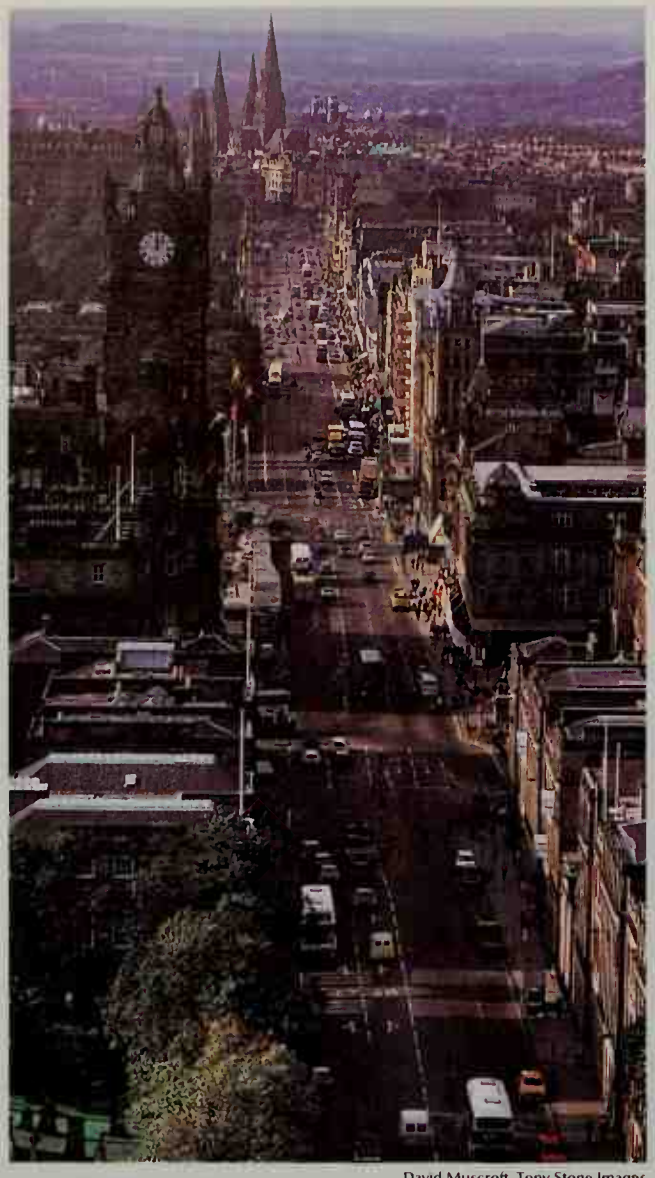
For much of its history, Scotland was an independent country. However, it frequently came into conflict with England, which occupies the southern part of the same island. Scotland and England brought an end to their struggles by uniting in the 1700's.

This article tells about the people, geography, and economy of Scotland. The article also traces Scotland's history up to the late 1700's. For a discussion of the United Kingdom as a whole, of Scotland's relation to the other divisions of the United Kingdom, and of the history of Scotland after 1782, see the *World Book* article United Kingdom.

Government

The United Kingdom is both a parliamentary democracy and a constitutional monarchy. The British monarch is the head of state, but a cabinet of elected officials

The contributors of this article are A. S. Mather, Professor of Geography at the University of Aberdeen, and Rodney Barker, Reader in Government at the London School of Economics.



David Muscroft, Tony Stone Images

Edinburgh is the capital of Scotland. The city's Princes Street is one of the world's most beautiful thoroughfares, lined with fashionable shops, hotels, and art galleries.

WORLD BOOK map

Scotland covers about a third of the island of Great Britain. England and Wales are also on the island.

called *ministers* actually governs the United Kingdom. The *prime minister* is the chief official.

Parliament makes the laws. Parliament includes the monarch, the House of Commons, and the House of Lords. Scotland elects 72 of the 659 members of the House of Commons, which holds most of the power. For more information on the British government, see **United Kingdom** (Government).

Many Scots long favored *devolution,* the transfer of some powers from the central government to regional governments, which would give Scotland more control over its own affairs. In 1997, the United Kingdom proposed plans for a new Scottish Parliament, and Scottish voters approved the plans. In 1999, the United Kingdom granted Scotland its own government, transferring many powers from the central government to the new government.

The Scottish Parliament meets in Edinburgh. It consists of 129 members, who serve four-year terms. Scottish voters elect most members directly, but some are elected by *proportional representation.* This system gives a political party a share of seats in the Parliament according to its share of the total votes cast in an election.

The first minister leads the Scottish government. The first minister is usually the leader of the political party that controls the most seats in the Parliament. The first minister is assisted by a committee of senior members of parliament called the Scottish Executive.

The Scottish Parliament makes laws for Scotland. Although the British monarch approves the laws, that is a formality. The Scottish government takes responsibility

Scotland's flag is called *St. Andrew's Cross.* The flag has never been officially adopted, but the Scottish people have flown it for hundreds of years.

Scotland's version of the Royal British Arms includes the arms of Scotland, England, and Ireland.

Facts in brief

Capital: Edinburgh.
Official language: English.
Area: 29,767 mi² (77,097 km²). *Greatest distances*—north-south, 274 mi (441 km); east-west, 154 mi (248 km). *Coastline*—about 2,300 mi (3,700 km).
Elevation: *Highest*—Ben Nevis, 4,406 ft (1,343 m) above sea level. *Lowest*—sea level along the coast.
Population: *Estimated 2002 population*—5,219,500; population density, 175 per mi² (68 per km²); distribution, 86 percent urban, 14 percent rural. *1991 census*—4,999,000.
Chief products: *Agriculture*—barley, cattle, milk, sheep, wheat. *Fishing*—cod, haddock, mackerel. *Manufacturing*—foods and beverages, electronic equipment, chemicals, industrial machinery, paper, and textiles. *Mining*—petroleum.

for most domestic matters, including health, education, and transportation. The United Kingdom's national government deals with foreign affairs, defense, taxation, and constitutional matters. However, the Scottish Parliament may raise or lower the income tax rate slightly.

Local government in Scotland is carried out by 32 unitary authorities that are directly responsible to the Scottish Executive in Edinburgh. Each unitary authority is supervised by an elected council. Local government is subject to national law and policy and has no independent lawmaking power. Local government is financed by a combination of *council tax* (local taxes) and grants from the national government. Local taxation is the responsibility of the Scottish Executive and the Scottish Parliament.

People

Population. About three-fourths of Scotland's people live in the lowlands of central Scotland, a region that makes up only about a sixth of the Scottish mainland. The rugged Highlands and the hilly uplands of southern Scotland are more sparsely populated. The Highlands, which cover about two-thirds of the Scottish mainland, have some of the most thinly populated areas in Scotland. Less than 2 percent of the people live in Scotland's three island authority areas of Orkney, Shetland, and the Western Isles.

One of Scotland's major problems has been emigration. Particularly in the 1960's, thousands of people left Scotland because of limited job opportunities. Many parts of Scotland have been focusing on promoting tourism and developing local businesses to help reduce emigration. New industries, such as the production of oil from the North Sea, have helped provide more employment opportunities.

Ancestry. Most Scottish people are descended from peoples who came to Scotland thousands of years ago. These groups included the Celts, Scandinavians, and a Celtic tribe from Ireland called the Scots. Each group influenced Scottish civilization.

Language. English is the official language throughout the United Kingdom. In Scotland, English is spoken in a variety of dialects.

About 80,000 Scots speak *Gaelic,* an ancient Celtic language. Most of these people live in the Highlands or on the islands west of the mainland. See **Gaelic language**.

Way of life

Industrialization has eliminated many of Scotland's old traditions and ways of life. Many fortified castles still stand in Scotland, remnants of its warlike past. But day-to-day living in Scotland is becoming more like that in other parts of the United Kingdom and Europe. Today, most of the people of Scotland are wage earners who live in or near cities.

City life. Small homes, row houses, and apartment buildings made of stone are common in Scotland's cities. Many Scottish cities developed around coal mining and heavy industry during the 1800's and early 1900's. Much of the housing at that time was of poor quality. However, after World War II ended in 1945, the government began extensive efforts to improve living conditions in Scotland. It replaced much of the housing with modern, government-owned dwellings. The councils that oversee the local government areas own the government dwellings, which are called *council houses.* By the end of the 1900's, privately owned housing was becoming more popular than government-owned housing in Scotland.

Crowding and pollution are rare in Scottish cities, partly because Scotland's heavy industry has declined. Glasgow ranked as a great industrial and commercial center in the late 1800's and early 1900's. It was known as the Second City of the British Empire, London being the first city. Five new towns, including East Kilbride and Cumbernauld, were built in the Central Lowlands to

J. Pugh, DPI

Picturesque fishing villages stand on the coasts of Scotland. Crail, shown here, is one such village on the country's east coast. In the late 1900's, fishing declined in its importance to the Scottish economy.

ease crowding in Glasgow. Although much heavy industry closed in the mid-1900's, new industries in light manufacturing and other fields have developed, keeping Glasgow and the Central Lowlands the industrial center of Scotland. But some towns in the area still face high unemployment rates.

Unlike the people in Glasgow, people in Aberdeen have seen great growth and prosperity since the 1970's. This growth is mostly due to the opening of offshore oil and gas fields under the North Sea. The fields provide many jobs and bring much money to the area. They have made Aberdeen the oil capital of Europe.

Rural life. Less than one-fourth of Scotland's people live in rural areas. Much of Scotland's countryside has rugged terrain and offers only a limited number of jobs and resources. Some rural workers fish, grow crops, raise livestock, or harvest timber. However, only about 2 percent of Scotland's employed people earn their living in farming, fishing, and forestry. As a result, many rural dwellers work in the cities.

The distinction between urban and rural communities in Scotland is often blurred. As a result of better transportation and greater contact with the cities, rural communities have become less distinctive and their people less close-knit. As in the cities, housing in rural areas greatly improved during the late 1900's. Fewer rural people live in apartments, but otherwise housing and social conditions in urban and rural areas are similar.

Food and drink. Favorite foods and beverages in Scotland increasingly resemble those in other parts of the United Kingdom. Most Scottish cooking is simple. Favorite traditional Scottish dishes include fish and chips, herring, roast beef, and roast lamb. The Scots also enjoy fine steaks from Scotland's famous Aberdeen-Angus cattle.

Other traditional Scottish foods include haggis, kippers, oatmeal, and salmon. *Haggis* is a famous national dish made from the heart, liver, and lungs of a sheep. These ingredients are chopped with *suet* (animal fat), onions, oatmeal, and seasonings, and then boiled in a bag made from a sheep's stomach. *Kippers* are smoked herring, a favorite breakfast dish. Oatmeal is used in many Scottish dishes, including porridge and *oatcakes* (flat cakes cooked on a griddle), both of which are popular for breakfast. Salmon is served smoked, grilled, or poached. Salmon taken from Scottish waters is considered one of the world's tastiest fishes.

In addition to traditional Scottish foods, other foods such as hamburgers, pizzas, and *curries* (stews spiced with curry) are popular in Scotland. Tea is also popular. The number of Scots who drink coffee has increased greatly since the mid-1900's.

One of the favorite alcoholic drinks in Scotland is Scotch whisky, or Scotch. The Scots have been making whisky since the 1400's. They export about 85 million gallons (322 million liters) of Scotch yearly.

Recreation. Most Scots enjoy sports and outdoor activities. Scotland's huge open lands make excellent recreational areas.

The Scots probably developed the modern game of golf, and it is still one of their favorite games. Scotland's numerous golf courses include the world-famous Royal and Ancient Golf Club of St. Andrews. See **Golf** (History).

Scotland's most popular organized sport is *association football,* or soccer. Thirty-eight professional teams play in the Scottish Football League. Leading teams play in European competitions, and the Scottish national team competes in the World Cup. Rugby football is also popular in Scotland.

The Highland Games, which resemble track meets, are held throughout the Highlands during the spring, summer, and early fall. Field events include tossing the *caber,* a long wooden pole that weighs about 180 pounds (82 kilograms). Athletes compete to see who can heave the caber the straightest. Other events of the Highland Games include footraces and dancing and bagpipe competitions. The British royal family traditionally attends the games held in Braemar.

David Hurn, Magnum

Bagpipes and kilts have been well-known symbols of Scotland for hundreds of years. Bagpipe bands in traditional Highland costumes are popular features at many Scottish events.

People from throughout the world come to fish for trout and salmon in the clear mountain streams of the Highlands. Hiking, mountain climbing, and shooting are also popular in the Highlands. The area around Ben Nevis in western Scotland is one of the best mountain-climbing regions in Europe.

Popular winter sports in Scotland include skiing and curling. *Curling* is a game in which the players slide heavy stones across a sheet of ice toward a target.

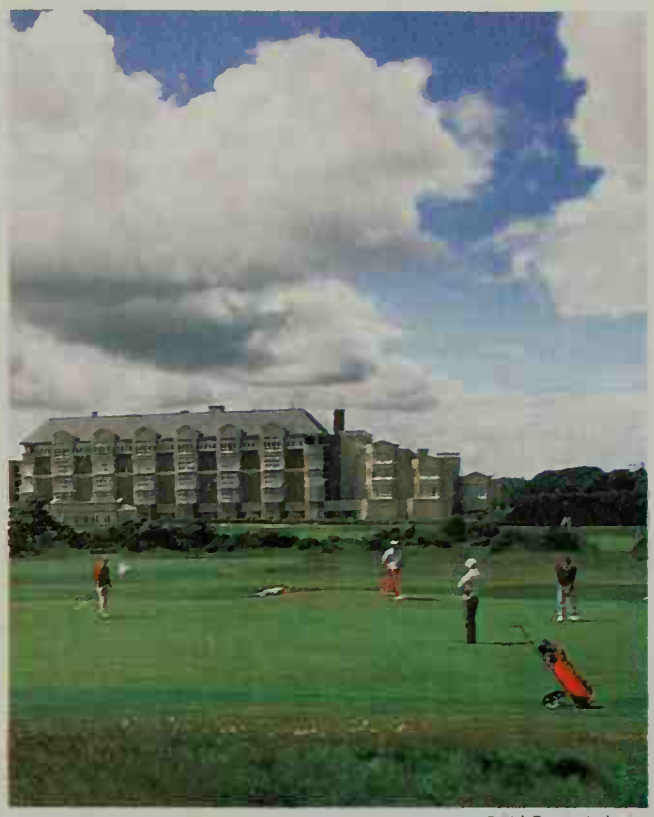
Education. Scotland's system of education is separate from that of England and Wales and from that of Northern Ireland. The Scottish Office Education Department and local education authorities supervise the school system in Scotland.

All Scottish children between the ages of 5 and 16 must attend school. Nearly all schools are supported by public funds. Scotland has few private schools, most of which are in Edinburgh.

For many years, Scotland had separate schools for vocational and academic education. But during the 1970's, these specialized schools were replaced with *comprehensive schools.* Comprehensive schools provide both types of education, and students take courses geared to their abilities.

Scotland has 12 universities—Aberdeen, Dundee, Edinburgh, Glasgow, Glasgow Caledonian, Heriot-Watt, Napier, Paisley, Robert Gordon, St. Andrews, Stirling, and Strathclyde. Aberdeen, Glasgow, and St. Andrews were founded in the 1400's. Edinburgh and Glasgow are the largest universities.

Religion. The Church of Scotland, a Presbyterian church, is the official church of Scotland. But the people may worship as they choose. Many Scots are Baptists, Episcopalians, Methodists, Roman Catholics, or members of Presbyterian churches other than the Church of Scotland.



British Tourist Authority

The Royal and Ancient Golf Club of St. Andrews, one of the world's most famous golf courses, lies near the North Sea. The modern game of golf probably developed in Scotland.

The Church of Scotland has about 2 million members. The members elect about 1,250 ministers and *elders* (officers) of the church to the General Assembly of the Church of Scotland, which meets once a year. The assembly is often called the *Voice of Scotland* because it discusses national and world affairs as well as church matters. The British monarch sometimes attends the assembly meeting.

The arts. Scotland has produced many famous artists, especially in the field of literature. The earliest Scottish literature was chiefly oral. It was sung or chanted by poet-singers called *bards,* who composed poetry and songs in the Gaelic language.

Between the 1300's and 1700's, famous Scottish poets included John Barbour, Gavin Douglas, William Dunbar, and Allan Ramsay. Robert Burns, who wrote during the late 1700's, became the national poet of Scotland. He wrote many works in Scots, the literary Scottish dialect. Many modern Scottish poets, including Hugh McDiarmid, Tom Scott, and Douglas Young, also have used Scots.

Most Scottish prose is written in English. Famous Scottish authors of the 1700's include James Boswell, who wrote a fascinating biography of the English writer Samuel Johnson, and John Arbuthnot, who wrote many great essays. In the 1800's, Thomas Carlyle produced brilliant histories and biographies, and John Lockhart became known for his works of literary criticism. Scotland's best-known novelists, Sir Walter Scott and Robert Louis Stevenson, also wrote during the 1800's. Scott's

Don Evins from Tom Stack

Sheep shearing is an important activity in many Highland communities. These skilled shearers are using hand clippers to remove the wool. The Highlands are well suited for raising sheep.

Scotland map index

Unitary authorities*

Aberdeen		D	6
Aberdeenshire		D	6
Angus		E	6
Argyll and Bute		F	4
Dumfries and Galloway		G	5
Dundee		E	6
East Ayrshire		G	4
Fife		F	6
Highland		D	4
Moray		D	5
North Ayrshire		G	4
Orkney Islands		A	5
Perth and Kinross		E	5
Scottish Borders		G	6
Shetland Islands		A	7
South Ayrshire		G	4
South Lanarkshire		G	5
Stirling		F	4
Western Isles		C	2

Cities and towns†

Aberdeen‡	201,099	D	6
Annan (Annandale and Eliksdale‡)	35,945	H	5
Arbroath (Angus‡)	94,288	E	6
Ayr (Kyle and Carrick‡)	113,290	G	4
Banff		C	6
Coatbridge (Monklands‡)	108,155	F	5
Cumnock and Doon Valley‡	43,750	G	4
Dalbeattie (Stewartry‡)§	23,058	H	5
Dingwall (Ross and Cromarty‡)	47,889	D	4
Dumbarton‡	75,973	F	4
Dumfries (Nithsdale‡)	57,149	H	5
Dunbar		F	6
Dundee‡	165,548	E	6
Dunfermline‡	125,529	F	5
East Kilbride‡	81,399	F	4
Edinburgh†	421,213	F	5
Elgin (Moray‡)	85,021	C	5
Falkirk‡	139,038	F	5
Fort William (Lochaber‡)	19,409	E	4
Galashiels (Ettrick and Lauderdale‡)	33,296	G	6
Glasgow‡	654,542	F	4
Greenock (Inverclyde‡)	97,932	F	4
Gretna Green		G	5
Hamilton‡	103,139	F	4
Hawick (Roxburgh‡)	35,294	G	6
Inverness	58,849	D	4
Inverurie (Gordon‡)	70,170	D	6
Irvine (Cunninghame‡)	137,094	G	4
Kilmarnock and Loudon‡	81,078	G	4
Kirkcaldy‡	144,574	F	5
Kirkwall		A	5
Kyle of Lochlash (Skye and Lochlash‡)	11,308	D	3
Lerrick		B	7
Lockerbie		G	5
Melrose		G	6
Motherwell‡	140,320	F	5
Musselburgh (East Lothian‡)	82,160	F	6
Nairn‡	10,680	D	5
Oban (Argyle and Bute‡)	65,873	E	3
Paisley (Renfrew‡)	203,407	F	4
Peebles (Tweeddale‡)	14,513	G	5
Penicuik (Midlothian‡)	81,453	F	5
Perth and Kinross‡	122,360	E	5
Peterhead (Banff and Buchan‡)	83,341	D	6
Prestwick		G	4
St. Andrews (North East Fife‡)	66,010	E	6
Stirling‡	81,147	F	5
Stonehaven (Kincardine and Deeside‡)	46,788	D	6
Stornoway		C	2
Stranraer (Wigtown‡)	30,410	H	4
Thurso (Caithness‡)	27,232	B	5

*Refer to key in upper left corner of map for unitary authorities near Glasgow and Edinburgh
†Populations are for districts, which may include rural areas as well as the city or town.
The British government does not report populations for cities and towns.
‡District name.
§Does not appear on map; key shows general location.
Sources: 1991 census preliminary figures, 1985 official estimates.

most famous work is *Ivanhoe* (1819). Stevenson's novels include *Treasure Island* (1883) and *Kidnapped* (1886). The Scottish writer J. M. Barrie wrote *Peter Pan* (1904) and other popular plays.

Scotland's first important painters were the portrait painters Allan Ramsay (the son of the poet) and Sir Henry Raeburn, who lived in the 1700's and early 1800's. Other famous painters since then include Sir James Guthrie, W. Y. Macgregor, William MacTaggart, Sir William Orchardson, John Pettie, and Sir David Wilkie.

Scottish music has traditionally centered on the bagpipe. The Scots divide bagpipe music into big music and little music. *Big music* includes warlike or sad songs called *pibrochs*. *Little music* includes marches and music for dancing. The Scottish reel, the Highland fling, the sword dance, and other traditional dances are performed to little music. The Edinburgh International Festival of the Arts, held in Edinburgh each August, features musical and dramatic productions.

The land

Scotland occupies the northern third of the island of Great Britain. The River Tweed and the Cheviot Hills form Scotland's southern border with England. The North Channel separates southwestern Scotland from Northern Ireland. The northwest coast faces the Atlantic Ocean. The east coast faces the North Sea, which separates Scotland from the mainland of Europe. For information on Scotland's climate, see the table with the *Climate* section of United Kingdom.

Land regions. Scotland has three main land regions. They are, from north to south, the Highlands, the Central Lowlands, and the Southern Uplands.

The Highlands are a rugged, barren region that covers the northern two-thirds of Scotland. Two major mountain ranges, the Northwest Highlands and the Grampian Mountains, rise in this region. The ranges have parallel ridges that run through the Highlands from northeast to southwest. A deep valley called *Glen More* or the *Great Glen* separates the two mountain ranges. The highest peak in the United Kingdom, 4,406-foot (1,343-meter) Ben Nevis, rises south of Glen More. The Highlands have two kinds of valleys—steep, narrow *glens* and broad, rolling *straths*. Much of the land in the Highlands is a treeless area called a *moor* or *heath*. The most rugged land lies along the west coast. Most Highlanders live on the narrow coastal plains.

The Central Lowlands are crossed by the valleys of the Rivers Clyde, Forth, and Tay. This region has Scotland's best farmland. Wide, fertile fields and low hills with patches of trees cover the entire region. About three-fourths of the Scottish people live in the lowlands.

The Southern Uplands consist of rolling moors, broken in places by rocky cliffs. The tops of the hills are largely barren, but rich pastureland covers most of the lower slopes. Many sheep and cattle are raised in the Southern Uplands. In the south, the uplands rise to the Cheviot Hills.

Rivers and lakes. The River Clyde is Scotland's most important river. Ships from the Atlantic Ocean can sail up the Clyde to Glasgow. The Clyde was narrow and shallow until the 1700's, when engineers widened and deepened the river to make it navigable. Scotland's longest rivers flow eastward into the North Sea. The Tay, 120 miles (193 kilometers) long, is the largest river in Scotland. It carries more water than any other river in the United Kingdom.

Many of Scotland's rivers flow into wide bays called *firths*. The firths of Clyde and Lorn lie on the west coast. The firths of Forth and Tay and Moray Firth are on the east coast. All ships bound for Glasgow must pass through the Firth of Clyde. A cantilever bridge for trains and a suspension bridge for other traffic span the Firth of Forth at Queensferry. The cantilever bridge, built in 1890, is one of the finest examples of its kind.

Most of Scotland's lakes, which are called *lochs*, lie in deep Highland valleys. Loch Lomond is Scotland's largest lake. It is 23 miles (37 kilometers) long and 5 miles (8 kilometers) wide at its widest point. A series of lakes extends through Glen More. These lakes are connected by canals and form the Caledonian Canal, which cuts across Scotland from Moray Firth to the Firth of Lorn. One of the canal's lakes, Loch Ness, is famous for its "monster." Some people claim to have seen a creature 30 feet (9 meters) long in the lake. Along the west coast of Scotland, the Atlantic Ocean extends inland in many narrow bays called *sea lochs*.

Islands. Scotland has hundreds of islands. A large group of islands called the Hebrides lies off the west coast of Scotland's mainland. The Orkney and Shetland groups lie north of the mainland and form the boundary between the North Sea and the Atlantic Ocean.

Economy

During the late 1900's, the economy in Scotland shifted greatly from heavy manufacturing to service industries. In the 1800's and the first half of the 1900's, large numbers of Scots worked in such industries as shipbuilding and engineering. Today, these businesses employ fewer of Scotland's workers. The service industries, light manufacturing, and the energy industry provide most of Scotland's jobs.

Service industries employ about two-thirds of the labor force in Scotland and account for about two-thirds of Scotland's economic production. Retail sales, finance and business services, education, and medicine lead the service industries in number of employees. Public administration, tourism, transportation, and communica-

Skyport from Publix

Ben Nevis, *center,* the highest peak in the United Kingdom, rises 4,406 feet (1,343 meters) in the Scottish Highlands. The area around it is one of Europe's best mountain-climbing areas.

tions also are major employers. Workers in Edinburgh have historically been more involved in administration and other service industries than in manufacturing.

Manufacturing. About one-fifth of Scotland's work force has jobs in manufacturing, which accounts for about one-fifth of Scotland's economic production. The chief manufactured products include food and beverages, electronic equipment, and chemicals. Industrial equipment, woolens, and whisky are products for which Scotland has long been famous.

Agriculture, forestry, and fishing. About three-fourths of Scotland's land is used for farming. Most of the land consists of *rough grazings,* rangelands that farmers use for grazing livestock. Scottish farmers developed many famous breeds of beef and dairy cattle, including Ayrshire, Aberdeen-Angus, Galloway, and Highland. They also developed the Clydesdale workhorse; the Shetland pony; and a sheepdog, the collie.

Livestock products, such as meat, milk, and wool, account for about three-fourths of Scotland's farm production. In the northeast, farmers produce much beef. Milk ranks as a major product in the southwest, which is traditionally associated with Ayrshire cattle. Farmers raise Scottish Blackface sheep on the rangelands of the Highlands and of southern Scotland.

Less than one-fifth of Scotland's land is suitable for growing crops. Farmers mainly plant grain, including barley, oats, and wheat. Much of the barley is used for brewing and distilling. Most of the remainder becomes livestock feed. Potatoes are also an important crop. Families own and operate most of the farms in Scotland.

Scotland's forest area almost tripled during the 1900's. However, forests cover only about 15 percent of Scotland's land area. The government has provided grants, and the state forestry service has planted trees to encourage expansion of Scotland's forests.

Fishing is an important activity in coastal towns. Important catches include haddock, cod, mackerel, herring, lobsters, and prawns. Aberdeen and Peterhead, on the east coast of Scotland, are among the leading fishing ports in Europe. Salmon are caught in the Tay and other rivers, and are raised on fish farms.

Energy sources. Oil and gas fields under the North Sea provide much of Scotland's energy. Pipelines connect the fields to the Scottish mainland and to shipment points on the Orkney and Shetland islands. Nuclear power plants supply about 45 percent of Scotland's electricity. Coal provides about 20 percent, and natural gas and hydroelectric power plants supply most of the rest. Since the 1970's, when the production of North Sea oil and gas began, coal mining has greatly declined. Coal was formerly Scotland's main energy source.

Transportation and communication. A dense network of roads serves most of Scotland. Fast highways link the main cities, and most highways are free of tolls. The government owns the railroads, which serve the major towns and cities in Scotland. Scotland's major airports are at Glasgow, Edinburgh, Prestwick, and Aberdeen. The world's busiest helicopter port is also at Aberdeen, where it serves the offshore oil industry.

Scotland has 12 daily newspapers. *The Scotsman,* published in Edinburgh, and *The Herald,* published in Glasgow, are Scotland's most influential newspapers.

Scotland receives radio and television programs from the British Broadcasting Corporation. It also receives programs from companies working under the Independent Television Commission.

WORLD BOOK map

Physical features

Arran (island)	D	2
Ben Macdui (peak)	C	3
Ben Nevis (peak)	C	2
Caledonian Canal	C	2
Cape Wrath	A	2
Cheviot Hills	E	3
Clyde, River	D	2
Dee, River	C	3
Don, River	C	3
Firth of Clyde (bay)	E	2
Firth of Forth (bay)	D	3
Firth of Lorn (bay)	D	2
Firth of Tay (bay)	D	3
Forth, River	D	3
Glen More (valley)	C	2
Grampian Mountains	C	2
Harris (island)	B	1
Inner Hebrides	C	1
Islay (island)	D	1
Jura (island)	D	2
Kinnairds Head	B	4
Kintyre Peninsula	D	2
Lewis (island)	B	1
Loch Lomond (lake)	D	2
Loch Ness (lake)	C	2
Mainland (island)	A	4
Mainland (island)	A	3
Minch, The (strait)	B	1
Mondahliath Mountains	C	2
Moray Firth (bay)	B	3
Mull (island)	D	1
North Channel	E	1
North Uist (island)	B	1
Northwest Highlands	B	2
Orkney Islands	A	3
Outer Hebrides	B	1
Pentland Firth	A	3
Pentland Hills	D	3
Shetland Islands	A	4
Skye (island)	C	1
Solway Firth	E	3
South Uist (island)	C	1
Spey, River	C	3
Tay, River	C	3
Tweed, River	D	3

History

Historians believe that the first people to live in Scotland came from other parts of Britain or the European mainland more than 7,000 years ago. They used flint tools and built boats. About 1800 B.C., people called the *Beaker folk* settled in northern Scotland. Their name comes from small clay containers called *beakers,* which

they buried with their dead. These people also made tools and other items of bronze. Celtic tribes probably had migrated to Scotland by the 600's B.C. The Celts came from western Europe and introduced the use of iron in Scotland. See Celts.

The Roman invasion. A Roman army commanded by Gnaeus Julius Agricola, the Roman governor of England, invaded Scotland in A.D. 80. The Romans called Scotland *Caledonia*. The invaders called the people of Scotland *Picts* (painted people) because they painted their bodies (see Picts).

Agricola defeated the Picts and returned to Rome. The Romans who remained in Scotland had trouble controlling the Picts. They built forts and walls to defend themselves. One of the most famous walls, Hadrian's Wall, was built across northern England in the A.D. 120's. It was named after the Roman emperor Hadrian. The Romans also built roads in the south of Scotland. They left in the early 400's.

Beginning of the Scottish kingdom. About A.D. 500, a Celtic tribe called the *Scots* came from northern Ireland and settled on Scotland's west coast. Saint Columba, an Irish monk, followed the Scots in 563. He founded a monastery and, with the help of the Scots, began to convert the Picts to Christianity.

In A.D. 843, Kenneth MacAlpin, king of the Scots, became king of the Picts as well. He established Alba, the first united kingdom in Scotland.

Many violent struggles for the Scottish throne began in the late 900's. In 997, Kenneth III became king by killing Constantine III. In 1005, Malcolm II killed Kenneth III. Duncan I, who followed Malcolm II, was murdered by Macbeth, one of his generals, in 1040. In 1057, Duncan's son, Malcolm III, killed Macbeth.

Struggles with England. Until the 1700's, Scotland and England were separate countries that often came into conflict. Malcolm III married an English princess and was greatly influenced by English customs. After the Normans conquered England in 1066, Malcolm permitted people from England who opposed the Norman leader, William the Conqueror, to settle in Scotland. He gave land to some of them and introduced feudalism into Scotland. Under feudalism, lords gave land to people in return for military and other services.

Malcolm died in 1093. The Scottish kings who followed him fought England for about 150 years. The English wanted to control the entire island of Great Britain, including Scotland. But the Scots were determined to remain independent. They frequently sided with France against the English. France and England were enemies.

During the reign of Alexander III, from 1249 to 1286, Scotland advanced in many ways. Agriculture and trade flourished, and many roads and bridges were built. A border was established between Scotland and England, and the two countries remained at peace.

Fight for independence. In 1286, Alexander's 3-year-old granddaughter, Margaret, followed him as ruler of Scotland. But she died four years later. A number of Scottish barons then fought for the throne. In 1292, Edward I of England recognized one baron, John Balliol, as king. Edward treated Balliol as a vassal and expected him to supply troops to fight the French. But he refused to do so and formed a military alliance with France instead.

Edward invaded Scotland in 1296 and won the important Battle of Dunbar. He then seized the Stone of Scone, the Scottish symbol of royal authority, and declared himself king of Scotland. The Scots soon renewed the revolt against English rule. Under William Wallace, Scotland's first popular hero, they won several victories. But in 1305, the English captured and executed Wallace.

Robert Bruce led the revolt after Wallace's death. He defeated Edward II in the famous Battle of Bannockburn in 1314. But Edward still refused to recognize Scotland's independence. The Scots officially declared their independence in 1320. In 1328, Edward III finally recognized Bruce as King Robert I of Scotland. Bruce died in 1329. Edward later tried to conquer Scotland but failed.

The House of Stuart. David II, Bruce's son, died in 1371 without an heir. Several families claimed the Scottish throne. The *House* (family) of Stuart won the struggle, and Robert II became king. The Stuarts kept close ties with France and fought continually with England. In 1503, James IV tried to make peace with England by marrying Margaret Tudor, an English princess. But he soon returned to a policy of close cooperation with France. The queen of France, Anne of Brittany, urged James to declare war against Henry VIII of England. James invaded England in 1513 and was killed in the Battle of Flodden Field. Scottish troops were again defeated by the English in 1542. James V, son of James IV, died that same year. His daughter, Mary, Queen of Scots, then became the ruler of Scotland.

The Scottish Reformation. Before the 1560's, the Roman Catholic Church was the official church of Scotland. Many Scottish leaders resented the Catholic Church's power and France's strong influence on the church. John Knox, a Scottish minister, led the Scots in establishing a reformed Protestant national church in the 1560's. This action occurred about the time that the Reformation, the religious movement that led to Protestantism, spread across northern Europe.

In 1567, Mary, a Catholic, was forced to give up the Scottish throne in favor of her infant son, James VI. Mary fled to England but was captured there and imprisoned. Elizabeth I of England had Mary executed in 1587. James was raised as a Protestant. A reformed Protestant church with a presbyterian form of government by councils of ministers and elders instead of by bishops became firmly established as Scotland's national church in his reign.

Important dates in Scotland

843 Kenneth MacAlpin established Alba, the first united kingdom in Scotland.
1314 Robert Bruce defeated an English army in the Battle of Bannockburn.
1320 Scotland declared its independence from England.
1328 The English recognized Scottish independence, and Robert Bruce became king of Scotland.
1560 A reformed Protestant church became the national church of Scotland.
1603 Scotland and England became joined under one king.
1707 The Act of Union joined Scotland with England and Wales, forming what later became known as the United Kingdom.
1715 The English put down the first Jacobite rebellion.
1746 The English won the Battle of Culloden Moor, ending the second Jacobite rebellion.
(For later dates, see United Kingdom [History]).

Detail of a mural (1900) by William Hole; Scottish National Portrait Gallery, Edinburgh, Scotland

The legendary Robert Bruce, *center,* defeated Edward II of England in the famous Battle of Bannockburn in 1314. As a result of the victory, Scotland eventually gained its independence from England, and Bruce was named King Robert I of Scotland.

War with the king. When Elizabeth I of England died in 1603, James VI of Scotland, a cousin of Elizabeth's, inherited the English throne. He moved to London, took the title of King James I of England, and ruled Scotland and England as separate kingdoms. Thus, the two countries became joined under one king. During his reign, James encouraged the establishment of Scottish colonies in Ireland and America. He also began to reorganize the Scottish church and tried to reintroduce bishops.

James's son, Charles I, continued the same policies of church reform. But in 1638, a group of Scots signed the National Covenant, a pledge to uphold the Church of Scotland and resist changes even when they came from the king. In 1642, civil war broke out between Charles and supporters of the English Parliament, many of whom were Puritans. Oliver Cromwell became the leader of the parliamentary forces. The Scottish Covenanters supported the English Parliament in the war. In 1646, Charles surrendered to Scottish forces in England, who turned him over to the English parliamentary forces. The English beheaded him in 1649.

After Charles I's death, the Scots persuaded his son, who later became Charles II, to agree to the National Covenant. They then defied Cromwell and declared Charles II king. But Cromwell defeated Charles's forces in the Battle of Dunbar in 1650. In 1654, Cromwell forced the Scots to unite with England.

Charles II finally became king in 1660. He dissolved the union between Scotland and England and, like his father and grandfather, ruled the countries separately.

Union with England. In the early 1700's, English and Scottish leaders realized that their countries must unite to preserve peace. In 1707, the Scottish and English parliaments passed the Act of Union. The act joined Scotland with England and Wales as a "united kingdom of Great Britain," which later became known as the United Kingdom. The Scots dissolved their Parliament and sent representatives to the British Parliament. But Scottish laws and the Church of Scotland remained unchanged.

Queen Anne, the last monarch of the House of Stuart, died in 1714. The House of Hanover then came to the throne in Britain. But many Highland Scots remained loyal to the Stuarts. They were called *Jacobites,* after *Jacobus,* the Latin form of *James,* after the Stuart king who had ruled from 1685 to 1688 as James II of England and James VII of Scotland. They supported James's son James Francis Edward Stuart, who was called the *Old Pretender* because he *pretended to* (claimed) the throne. In 1715, James Francis Edward Stuart helped lead the Jacobites in a rebellion that attempted to restore the Stuarts as Britain's rulers. The rebellion was crushed, and James fled to France.

The Highlanders revolted again in 1745. This time, they were led by James's son Charles Edward Stuart, the *Young Pretender.* The Highlanders called him *Bonnie Prince Charlie.* Charles's forces easily defeated the English troops in Scotland and then marched into England. In 1746, the government troops forced Charles into battle on Culloden Moor and defeated him. Charles fled back to the Highlands and escaped to France.

As a result of the revolt, the English executed many clan chiefs. They also disarmed the Highlanders and outlawed kilts and bagpipes. These restrictions were removed in 1782, after the threat of more Jacobite rebellions had passed. From the late 1700's to the mid-1800's, a period called the Highland Clearances, thousands of Scottish families lost their homes. They were evicted by landlords who found it more profitable to use the land to raise sheep. Many of these people emigrated.

For a continuation of the history of Scotland, see **United Kingdom** (History).

A. S. Mather and Rodney Barker

Related articles in *World Book* include:

Rulers

Bruce, Robert
Duncan I
James (I, of England)
Macbeth
Mary, Queen of Scots

Political and military leaders

Balfour, Arthur J.
Bothwell, Earl of
Campbell-Bannerman, Sir Henry
Haig, Douglas
Wallace, Sir William

Other biographies

Adam (brothers)
Baird, John L.
Broom, Robert
Brown, Robert
Burns, Robert
Carlyle, Thomas
Dunlop, John B.
Fleming, Sir Alexander
Frazer, Sir James G.
Higgs, Peter Ware
Hume, David
Kelvin, Lord
Knox, John
Lipton, Sir Thomas
Manson, Sir Patrick
Maxwell, James Clerk
McAdam, John Loudon
Mill, James
Napier, John
Nasmyth, James
Park, Mungo
Raeburn, Sir Henry
Ramsay, Sir William
Rob Roy
Scott, Sir Walter
Selkirk, Earl of
Smith, Adam
Stevenson, Robert
Stevenson, Robert Louis
Telford, Thomas
Thomson, James
Watson-Watt, Sir Robert A.
Watt, James

Cities

Aberdeen
Dundee
Edinburgh
Glasgow
Inverness
Saint Andrews

History

Bannockburn, Battle of
Caledonia

Celts		Highland Clearances
Covenanters		Picts
Gaels		Stuart, House of

Islands

Hebrides	Orkney Islands	Shetland Islands

Physical features

Ben Nevis	Firth of Forth	Loch Lomond
Clyde, River	Inchcape Rock	Tweed, River

Other related articles

Bagpipe	Glasgow, University of
Clan	Golf (History)
Curling	Loch Ness monster
Edinburgh, University of	Scone, Stone of
Europe (picture: The North-west Mountains region)	Tartan
	Tweed

Outline

- **I. Government**
  - A. The Scottish Parliament
  - B. Local government
- **II. People**
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  - B. Ancestry
  - C. Language
- **III. Way of life**
  - A. City life
  - B. Rural life
  - C. Food and drink
  - D. Recreation
  - E. Education
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- **IV. The land**
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- **VI. History**

Questions

What are *glens, straths,* and *moors?*
What are some popular foods in Scotland?
Who leads Scotland's own government?
What was the Act of Union?
What are the Highland Games?
Who were the Jacobites?
Where are most of Scotland's oil and gas fields?
Why is the General Assembly of the Church of Scotland often referred to as the *Voice of Scotland?*
What are *rough grazings?* How are they important to Scottish farmers?
What are some famous breeds of animals developed by the Scots?

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Scotland Yard is the headquarters of the London Metropolitan Police. In popular usage, however, the name *Scotland Yard* means a branch of the London police called the *Criminal Investigation Department* (C.I.D.). The C.I.D. handles all aspects of criminal investigation in metropolitan London, and police departments throughout the United Kingdom seek its help with difficult cases. Scotland Yard is known throughout the world for its skill and crime-solving techniques.

In addition to the C.I.D., the Metropolitan Police have three other main departments. The Uniform Department patrols the streets to guard against crime and help people with problems. The Traffic Department enforces traffic laws and promotes safety on streets and highways. The Special Branch functions mainly as an information-gathering agency. It also investigates individuals and groups that may endanger national security and protects government officials and distinguished foreign visitors.

The London Metropolitan Police was founded by Sir Robert Peel, a British statesman, in 1829. Ever since, police officers have been called *bobbies,* after Sir Robert's nickname. The original headquarters stood near buildings formerly used to house kings and other important visitors from Scotland. As a result, the police facilities became known as *Scotland Yard,* though the street address was No. 4 Whitehall Place. In 1890, the police moved into offices on the Thames Embankment. These offices were named New Scotland Yard. In 1967, New Scotland Yard moved to the Westminster section of London, near the Houses of Parliament. John I. Thornton

Scott, Barbara Ann (1928-), a Canadian ice skater, won the women's gold medal in figure skating at the 1948 Winter Olympic Games. Scott became the first Canadian figure skater to win an individual championship at the Olympics. In 1946, Scott won the Canadian and North American championships. In 1947, she won the world and European championships, becoming the first North American to win the European championship. Afterward, Canadians welcomed her home as a hero. In 1948, Scott again won the European and world championships, as well as the Olympics title. She then turned professional and skated in ice shows until 1955, when she retired. She was born on May 9, 1928, in Ottawa. William F. Reed

Scott, Coretta. See King, Coretta Scott.

Scott, Dred. See Dred Scott Decision.

Scott, Duncan Campbell (1862-1947), was a Canadian poet. He was most noted for his romantic poems about Indian life and the primitive violence of the northern Canadian wilderness. "The Onondaga Madonna" and "The Forsaken" are two of his best-known poems about the Indians. His "Piper of Arll" describes the sea. Scott published his first volume of poetry, *The Magic House and Other Poems,* in 1893. He also wrote short stories, biographies, a novel, and a play.

Scott was born on Aug. 2, 1862, in Ottawa. He worked in the Canadian Department of Indian Affairs from 1879 to 1932. As an official of this department, he visited Indian territories throughout Canada. Scott's contacts with the Indians are reflected in his poetry. Rosemary Sullivan

See also Canadian literature (Confederation to World War I).

Scott, F. R. (1899-1985), was a Canadian poet and legal scholar. He wrote witty, satirical poems about public figures and the Canadian social system. He also wrote about nature, especially through symbolic interpretations of the northern Canadian landscape. Collections of Scott's poetry include *Overture* (1945), *Signature* (1964), and *The Collected Poems of F. R. Scott* (1981). He edited such influential poetry anthologies as *New Provinces: Poems of Several Authors* (1936). His translations of French-Canadian literature into English include *Poems of French Canada* (1977).

Francis Reginald Scott was born on Aug. 1, 1899, in Quebec City. He taught law at McGill University in Montreal for over 30 years. He was a supporter of civil rights. Laurie R. Ricou

Scott, Robert Falcon (1868-1912), a British explorer and naval officer, became the first person to reach the South Polar plateau. He reached it on an expedition that took place from 1901 to 1904. On Dec. 30, 1902, Scott reached a latitude of approximately 82° 179′, about 520 miles (840 kilometers) from the true South Pole. The latitude reached by Scott was the farthest south that anyone had then gone.

Scott's successes led the British government and Royal Geographical Society to appoint him commander of an expedition to the true South Pole. Leading the expedition, Scott sailed in 1910 from New Zealand on the *Terra Nova*. His party reached Cape Evans on Ross Island and set up headquarters there. Scott started over the ice with sleds in November 1911. The men reached the pole on Jan. 17, 1912, but they found that Roald Amundsen, a Norwegian explorer, had already reached it about five weeks earlier, on Dec. 14, 1911. On the return trip, all five members of the Scott party died. Three bodies and records and diaries the men had kept were found at their last camping site. Factors contributing to the deaths included cold, hunger, illness, poor organization, insufficient fuel for motor-powered sleds, and lack of ponies and dogs to pull sleds. Scott was born in Devonport. Barry M. Gough

See also **Amundsen, Roald; Antarctica** (The "Heroic Era"; map; picture).

Scott, Sir Walter (1771-1832), was a Scottish romantic writer. He created and popularized historical novels in a series called the *Waverley* novels. In his novels, Scott showed his unique genius for re-creating social history. He arranged his plots and characters so the reader can enter into the lives of both great and ordinary people caught up in violent, dramatic changes in history.

Scott's art shows the influence of the Enlightenment of the 1700's. He believed every human was basically decent, regardless of class, religion, politics, or ancestry. Tolerance for different ways of life is a major theme in his historical works. The *Waverley* novels express his belief in the need for social progress that does not reject the traditions of the past. He was the first novelist to portray peasant characters sympathetically and realistically, and he agreed with the poet William Wordsworth's glorification of common people. He was equally just to people in business, soldiers, and even kings.

Scott's amiability, generosity, and modesty made him popular with his fellow writers. He declined the offer of poet laureate in 1813 and supported Robert Southey, who received the honor. Scott entertained on a grand scale at Abbotsford, his famous estate.

Scott's influence can be seen in the works of Victor Hugo and Honoré de Balzac of France, James Fenimore Cooper of the United States, and Leo Tolstoy of Russia. But despite his influence, Scott's reputation declined from the late 1800's to the mid-1900's. His reputation has begun to rise again. But it probably will never reach the heights it achieved during Scott's lifetime. Literary historians regard his death in 1832 as marking the close of the romantic age in English literature.

His life. Scott was born in Edinburgh. His father, who was a successful lawyer, had young Walter trained for a law career. Scott became an attorney in 1792, and he practiced law actively for many years.

A childhood illness, probably polio, left Scott lame in his right leg. But he had unusual physical strength, and was an enthusiastic outdoorsman. He enjoyed taking trips into the Scottish countryside. These trips gave him firsthand knowledge of the life of rural people, and provided material for his first major publication, *Minstrelsy of the Scottish Border* (1802-1803). This book was one of the great early collections of popular songs and ballads. *Minstrelsy* led to his first long verse poem, *The Lay of the Last Minstrel* (1805). The poem tells the legend of a famous goblin, and describes much about life along the English-Scottish border in the 1500's. Scott's interest in collecting and writing ballads was partially inspired by his knowledge of German writers, especially Gottfried August Bürger and Johann Wolfgang von Goethe. His uses of rhythm and meter in his poems greatly influenced other writers, especially Lord Byron.

Scott continued his success at narrative poetry with *Marmion* (1808), which includes his best-known ballad, "Lochinvar." In 1810, Scott wrote his most popular story-poem, *The Lady of the Lake*. This romantic tale, set in the famous Trossach Mountains, deals with picturesque Highland customs and history.

Despite his enormous success and fame, Scott's last years were sad. They were marked by illness and financial difficulties brought on by the failure of a publishing company in which he had an interest.

The Waverley novels. After the publication of his first novel, *Waverley,* in 1814, Scott devoted himself primarily to fiction. Scott's progress to historical novels was natural. His talents as a storyteller and as a creator of character, as well as his gift for realistic Scottish dialect, could be better realized in novels than in poetry.

Waverley describes a Scottish rebellion against England in 1745. The novel was published anonymously, without the benefit of Scott's name. But the book was a success. From 1814 to 1832, Scott wrote 27 other novels, four plays, and much nonfiction. All of Scott's novels were referred to as part of the *Waverley* series, because the author was identified on the title page only as "The Author of *Waverley*." Scott's authorship was officially revealed in 1827, but it had been known for years.

Scott wrote frequently about the conflicts between different cultures. *Ivanhoe* (1819) deals with the struggle between Normans and Saxons, and *The Talisman* (1825) describes the conflict between Christians and Muslims. The novels dealing with Scottish history are probably Scott's best. They deal with clashes between the new commercial English culture and an older Scottish culture. Many critics rank *Old Mortality* (1816), *The Heart of Midlothian* (1819), and *St. Ronan's Well* (1824) as Scott's best novels. Other works in the *Waverley* series include *Rob Roy* (1817), *A Legend of Montrose* (1819), and *Quentin Durward* (1823). Frederick W. Shilstone

Additional resources

Wagenknecht, Edward. *Sir Walter Scott.* Continuum, 1991.
Wilson, A. N. *A Life of Walter Scott: The Laird of Abbotsford.* 1980. Reprint. Mandarin (UK), 1996.

Scott, Winfield (1786-1866), a United States Army officer for more than 50 years, served in the War of 1812, the Mexican War (1846-1848), and the American Civil War (1861-1865). His troops fondly called him "Old Fuss and Feathers" because he loved colorful uniforms.

Scott was born near Petersburg, Virginia. He attended

William and Mary College and then studied law. He gave up law in 1808 to join the U.S. Army.

When the War of 1812 broke out, he became a lieutenant colonel and went to the Canadian border. Scott was captured at the Battle of Queenston Heights, near Niagara Falls, but he was freed a month later. As a colonel, Scott carried out a successful attack on Fort George, also near the falls, and took charge of that post. He became a brigadier general in March 1814 and fought at Chippewa and Lundy's Lane, major battles near the Canadian border. Two horses were shot from under him at Lundy's Lane. Scott fought on so stubbornly that he had to be carried from the field, severely wounded. He became a national hero, and Congress and the state of Virginia voted him a medal. He was a major general when the war ended.

In 1825, Scott prepared the first complete manual of military tactics in the U.S. Army. He enlarged *Infantry Tactics* (1835) and wrote his autobiography in 1864. He became general in chief of the Army in 1841.

In the Mexican War, in 1847, Scott led an army into Mexico. He won at Veracruz, Cerro Gordo, Contreras, Churubusco, Molino del Rey, and Chapultepec, and his forces captured Mexico City. Scott, active in the Whig Party, ran for president in 1852 on the Whig ticket. He lost to Democratic candidate Franklin Pierce.

Early in 1861, Scott went to Washington, where he recruited men to defend the capital. When the Civil War began in April, Scott, a Southerner, refused to join the Southern forces because he believed in the Union. Scott retired from the Army as a lieutenant general in 1861.

Michael F. Holt

See also Mexican War (Scott's campaign; Principal battles); War of 1812 (Chief battles of the war).

Scott Air Force Base, near Belleville, Illinois, is headquarters of the United States Transportation Command, Air Force Communications Command, and Air Weather Service. The Transportation Command includes the Navy's Military Sealift Command, the Army's Military Traffic Management Command, and the Air Force's Air Mobility Command (formerly known as the Military Airlift Command). An Air Force general heads both the Transportation Command and the Air Mobility Command. Scott Air Force Base was established in 1917 and covers 3,000 acres (1,200 hectares). It was named for Corporal Frank S. Scott, the first enlisted U.S. soldier to die in an aircraft accident. Wayne Thompson

Scottie. See Scottish terrier.

Scottish deerhound was for hundreds of years a dog of the nobility. In Scotland, only people with the rank of earl or higher could own deerhounds. The dog stands from 30 to 32 inches (76 to 81 centimeters) tall, or taller. It weighs from 75 to 110 pounds (34 to 50 kilograms). Its wiry coat is dark blue-gray, light gray, brindle, yellow, sandy-red, or fawn-red. Scottish lords bred the dog to hunt wild deer, but it is rarely used for hunting today. Critically reviewed by the American Kennel Club

Scottish terrier is a breed of dog first raised in the Scottish Highlands in the 1800's. Commonly called "Scottie," it is the only breed with the official name of Scottish terrier. However, the cairn, Skye, and West Highland white terriers are also native to Scotland.

The Scottish terrier is a small dog with a chunky body and short legs. It weighs 18 to 22 pounds (8 to 10 kilograms). It has a hard, wiry coat and a long head with small, upright ears. It may be wheat, sandy, or steel-gray in color, often with darker stripes. It also may be black. See also **Dog** (picture: Terriers).

Critically reviewed by the American Kennel Club

Scottsboro Case was one of the most important cases of the civil rights movement in the United States. The name actually refers to several court cases that lasted almost seven years during the 1930's. Three of the cases eventually were tried before the Supreme Court of the United States. The Scottsboro Case focused attention on the problems of blacks in the South. Many people believe the case started the civil rights movement.

The case began in 1931 in Scottsboro, Alabama. Several teen-agers, some black and some white, were hitching rides on a train. A fight broke out between the blacks and whites. The whites accused nine blacks of raping two white women in the group. The youths came to be called the "Scottsboro boys." Eight were sentenced to death. The trial of the ninth was declared a mistrial. The Supreme Court overturned the convictions in 1932 in the case of *Powell v. Alabama*. The court ruled that the defendants had not been well represented by lawyers.

Alabama officials refused to drop the case. A new trial for one of the defendants, Haywood P. Patterson, began in 1933 in Decatur, Alabama. By then, the case had attracted national attention, and many people believed the Scottsboro boys to be victims of racial prejudice. The Communist Party hired a famous non-Communist attorney, Samuel S. Leibowitz, to represent Patterson. One of the two supposed rape victims retracted her testimony during the trial. The jury convicted Patterson. But the judge disagreed with the verdict and ordered a new trial. In December 1933, Patterson and another defendant, Clarence Norris, were convicted of rape in a third trial.

In 1935, the Supreme Court overturned the two convictions because blacks had not been allowed to serve on juries in Alabama. However, Alabama officials refused to drop the charges against any of the defendants. Trials in 1936 and 1937 resulted in conviction and long prison sentences for five of the defendants. The charges against the other four defendants were dropped.

By 1950, four of those convicted were paroled. The

WORLD BOOK photo by Walter Chandoha

The Scottish deerhound was bred to hunt wild deer.

fifth escaped to Michigan, where the governor refused to surrender him to Alabama officials. Dan T. Carter

Scottsdale (pop. 202,705) is one of the largest cities in Arizona. It lies in central Arizona, just northeast of Phoenix (see **Arizona** [political map]). Scottsdale's warm climate and many resorts and golf courses make it a popular winter vacation place. Old West Scottsdale in the downtown area resembles an old frontier town.

Major Winfield Scott, a Union Army chaplain during the Civil War in America (1861-1865), bought land in what is now downtown Scottsdale in 1888. That year is considered the city's founding date. Scottsdale was a small agricultural community until after World War II ended in 1945. During the mid-1900's, the construction of electronics equipment factories in the area helped the population to increase tremendously. Scottsdale became one of Arizona's fastest-growing cities and attracted many artists and craftworkers. It was incorporated as a town in 1951 and received a city charter in 1961. In the 1980's, annexations of territory north of the city greatly increased its area. Much of this part of the city is uninhabited desert and mountain land. In the mid-1990's, the city established the McDowell Sonoran Preserve to save land in this area from development. Scottsdale has a council-manager form of government. Kristi H. Dempsey

Scotus. See **Duns Scotus, John.**

Scout. See **Boy Scouts; Girl Scouts; Scouts Canada.**

Scout is a person sent out to explore an unknown area and obtain information. The first explorers of the American frontier often served as scouts for colonial armies. Many of these scouts were fur traders. They knew the Indian tribes and found mountain passes and camping places. The first settlers of Oregon and California employed fur traders as guides. One well-known American scout was Kit Carson (see **Carson, Kit**). Dan L. Flores

Scouts Canada is an organization that works to help Canadian youth become resourceful and responsible citizens. It provides opportunities and guidance for young people to develop physically, mentally, socially, and spiritually. Scouts Canada accepts both boys and girls as members.

The principles of Scouts Canada are:

"Man must, to the best of his ability,

"Love and serve God;

"Respect and act in accordance with the human dignity and rights of individuals;

"Recognize the obligations on himself to develop and maintain his potential."

Age groups. Canadian Scouts are divided into five age groups: (1) Beavers, (2) Wolf Cubs, (3) Scouts, (4) Venturers, and (5) Rovers. Each group follows a program designed for its specific needs. Programs may be adapted to meet local conditions, such as those of Arctic communities, and the needs of ethnic groups and of disabled members.

Beavers are from 5 to 7 years old. They are organized into groups called *colonies,* most of which consist of 20 to 25 members. The Beaver program emphasizes sharing. There are no badges or awards. Beavers wear brown vests over their own clothing, blue ties, and brown-and-blue hats. They make "beaver tails" of felt and sew them onto their hats. The color of the tail indicates the Beaver's age and degree of development.

Wolf Cubs are from 8 to 10 years old. Groups of Wolf Cubs are called *packs.* Most packs consist of 24 Cubs and are divided into four small units called *sixes.* Wolf Cubs learn to work and play in groups. They try various hobbies and handicrafts. Cubs can earn up to 5 stars and 25 badges for their achievements. Wolf Cubs wear the same uniform as Scouts, Venturers, and Rovers. It consists of a tan shirt, navy trousers or skirt, and a navy beret. Each age group wears its own colored insignia.

Scouts range in age from 11 to 14. They form *troops* of 20 to 30 members and smaller groups called *patrols.* Scouts go on camping trips and learn such skills as hiking, swimming, outdoor cooking, and first aid. They also develop individual hobbies, physical fitness, and leadership skills. Scouts can earn up to 13 *achievement badges* and 31 *challenge badges* for their accomplishments.

Venturers are from 14 to 17 years old. They form groups called *companies,* which elect officers and plan activities based on the interests of their members.

Rovers range from 18 to 26 years old. The Rover program is determined by the Rover group. It provides members with opportunities for individual development and a chance to explore various careers.

Organization. About 300,000 young people are active in Canadian Scouting. Each Scout pays an annual fee. Local Scout units are sponsored by churches, service clubs, schools, and other community groups. Scouts Canada grants charters to the sponsoring organizations. It works closely with L'Association des Scouts du Canada, a separate organization that provides Scouting programs for French-speaking Canadian Scouts. The Chief Scout of Canada heads both organizations. Traditionally, the governor general of Canada serves as the Chief Scout. Scouts Canada's national office is in Ottawa.

History. The Scouting movement in Canada began in 1908. On June 12, 1914, a Canadian Scouting organization was incorporated as the Canadian General Council of the Boy Scout Association. Between 1946 and 1976, the group was known as the Boy Scouts of Canada. In 1976, the group became known as Scouts Canada. Membership has been open to both boys and girls since 1992. Critically reviewed by Scouts Canada

See also **Boy Scouts; Girl Guides; Girl Scouts.**

Scranton (pop. 76,415), is an important manufacturing center in northeastern Pennsylvania. The city lies on the Lackawanna River in a valley of the Appalachian Mountains (see **Pennsylvania** [political map]). The Pocono Mountains resort area is nearby. Scranton and the neighboring cities of Wilkes-Barre and Hazleton form a metropolitan area of 624,776 people.

The products of Scranton's many factories include appliances, books, clothing, electronic devices, heating and air-conditioning equipment, machinery, and textiles. Nay Aug Park is a large recreational area in the heart of the city. Such sites as the National Railroad Museum, the Everhart Museum, and Montage Mountain with its ski slope and other recreational facilities attract many visitors. Scranton is the home of Marywood University, the University of Scranton, Lackawanna Junior College, and the International Correspondence Schools, one of the world's oldest private home-study schools.

The first permanent settlement on the site of what is now Scranton was established in the 1780's. Scranton became an incorporated city in 1866. It was named for George W. Scranton, who had been the chief founder of

an ironworks there in 1840. The city's iron industry used nearby deposits of *anthracite* (hard coal) as fuel. By 1900, coal mining had become the area's chief economic activity. In the 1950's, a decrease in the demand for anthracite led to the closing of many of the city's mines. But economic development programs have attracted new businesses to the area. A downtown revitalization project in the late 1900's centered on the construction of a new shopping complex, The Mall at Steamtown.

Scranton is the seat of Lackawanna County and has a mayor-council form of government. William C. Rense

Screen, Projection. See Projection screen.

Screen printing is a printmaking technique in which ink is forced through a piece of silk onto paper or other material. The screen process is used commercially to print such items as billboard illustrations, package labels, and fabric designs. It is sometimes called *silk-screen printing*. In art, screen printing is called *serigraphy*. This article describes serigraphy.

To make a screen print, the artist uses a piece of silk stretched tightly across a wood frame to form a screen. Such materials as nylon, polyester, or wire mesh may be substituted for silk. The artist places thick ink along one edge of the screen and then spreads the ink across its surface with a rubber blade called a *squeegee*. The squeegee distributes the ink or paint evenly and presses it through the weave of the silk onto the material below. In most cases, the material is paper, but artists also use fabric, linoleum, glass, and wood for their prints.

The artist uses stencils to mask out parts of the design that are not to be printed. Most stencils are made of cut paper and produce designs with crisp, clean edges. Designs can also be painted on the screen with glue or lacquer. When printed, such designs appear to be made of brushstrokes rather than cutout shapes.

Many colors can be printed on a single surface. However, the screen must be cleaned, prepared with a new stencil, inked, and printed separately for each additional color.

The Chinese used stencil printing as early as A.D. 1000 to make designs on fabric. The use of silk for the screen was begun in France in the 1800's and was primarily used for commercial purposes. Artists began exploring the screen process in the 1930's. During the 1960's, it became a favorite printmaking technique with members of the Pop art movement, including Robert Indiana, Robert Rauschenberg, and Andy Warhol (see **Pop art**).

Elizabeth Broun

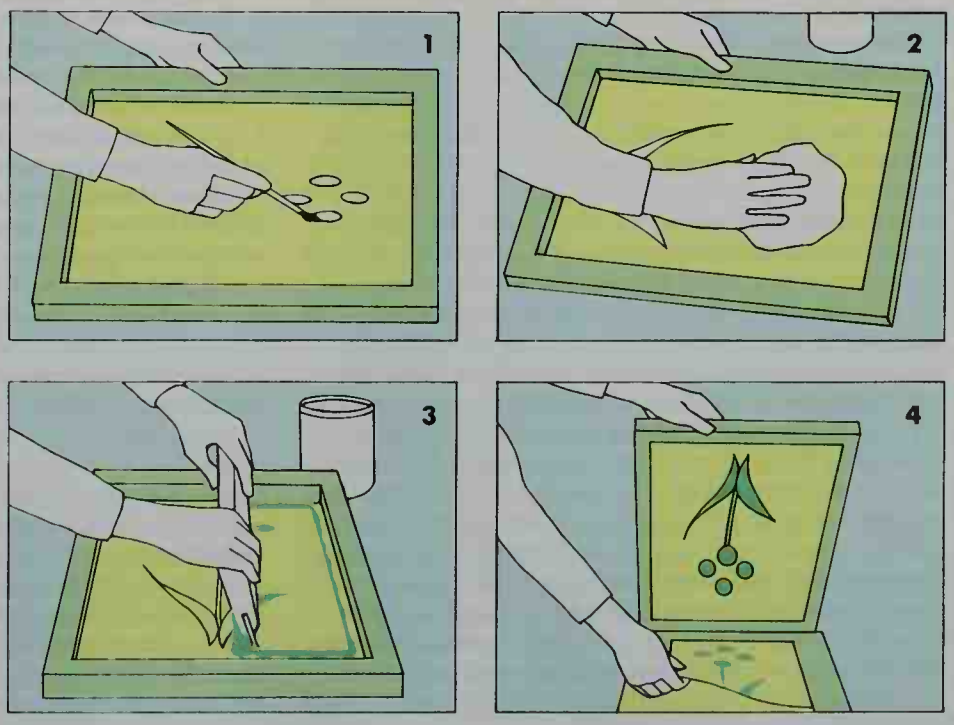
Screw is an inclined plane wrapped in a spiral around a shaft. The screw is one of the *six simple machines* developed in ancient times. The other five are the lever, the wheel and axle, the pulley, the inclined plane, and the wedge. See **Machine** (Six simple machines).

A screw consists of two main parts—the *body* and the *thread*. The body of a screw may be a cone or a cylinder. The center line of the body is called the *axis*. The thread is the inclined plane that sticks out from the body. The distance between two *adjacent* (neighboring) crests of the thread is known as the *pitch*.

Uses. Screws have many practical applications, especially as fasteners. The most common are the *wood screw* and *machine screw*. When rotated, such screws can be made to move into, or out of, an object. As the screw rotates one full turn, it travels a distance equal to its pitch. Most wood screws and machine screws have a slotted or recessed head into which a screwdriver is placed to turn the screw. Screws come in various sizes and shapes. They are made of steel, copper, aluminum, and other metals that are easy to form.

In addition to holding materials together securely, screws perform many other functions. Screws open and close nearly all vises. The screw's ability to overcome resistance with relatively little force makes it ideal for use in boring and drilling tools.

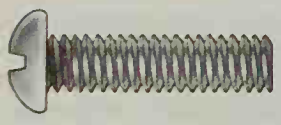
A *jackscrew* combines a screw with a lever. This device raises heavy loads without requiring great effort. Jackscrews can lift automobiles and other heavy objects, even houses.



Screen prints can be made in several ways. These pictures illustrate a technique using a greasy liquid called *tusche*. First, the artist paints a design onto a screen with tusche (picture 1) and allows the liquid to dry. Then a glue-and-water mixture is applied. After the mixture dries, it is washed with a solvent (picture 2), which removes the tusche and its glue coating. The artist then applies ink with a squeegee (picture 3). The ink passes through the open areas—but not the glue-covered areas—onto the paper below. The artist removes the printed design (picture 4) and hangs the sheet up to dry.

WORLD BOOK illustrations by David Cunningham

Some kinds of screws

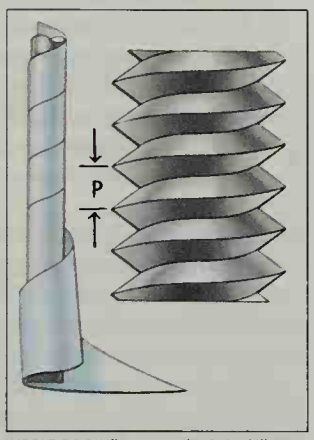


Round head machine screw

Flat head machine screw

Round head wood screw

Flat head wood screw



WORLD BOOK illustrations by Oxford Illustrators Limited

A screw is an inclined plane that spirals around a pole. A strip of paper wrapped around a tube, *above left,* illustrates this principle. The spiral part that extends from the pole is called the *thread.* The distance between threads, indicated by the letter P is known as the *pitch.*

Many screws help produce motion. A *marine screw propeller* pushes water backward, causing the boat or ship to move forward. Similarly, an airplane propeller is an *airscrew* that pushes back air and makes the plane move forward. See **Propeller.**

The screw also performs important operations in delicate and complex machinery. *Differential screws* enable objects to be spaced apart with great precision. The rotation of special screws in timing devices causes switches to turn on or off at certain times. The *micrometer* uses the revolutions of extremely fine threads to measure small dimensions with great accuracy (see **Micrometer**).

History. Some historians claim a Greek philosopher and mathematician named Archytas, who lived about 400 B.C., invented the screw. The ancient Greeks used screws for various purposes. The Greek mathematician and inventor Archimedes supposedly developed a machine that uses a screw to raise water (see **Archimedean screw**). The ancient Greeks also developed the *screw press,* a device consisting of two flat surfaces connected with screws. Tightening the screws brings the surfaces together and puts increasing pressure on whatever is placed between the surfaces. The Greeks used the screw press to squeeze juice from grapes to make wine and from olives to produce oil.

For many centuries, screws were made with simple hand tools. But during the 1500's, engineers developed the *screw-cutting lathe,* a machine that permitted more efficient and precise production of wooden and metal screws. Screws then began to replace nails and pegs as fasteners in joining hinges and other metal items to wood and in holding together parts of locks, watches, and other articles. Advancements in techniques for cutting finer, more exact threads led to the adoption in the mid-1800's of the first standardized screw thread. Screws with points that could be easily twisted through wood also appeared during the 1800's. Previously, all screws had flat ends and could be inserted only in specially drilled holes. W. David Lewis

See also **Bolt.**

Scriabin, *skree AH bihn* or *SKRY AHB yihn,* **Alexander** (1872-1915), was a Russian composer and pianist. In 1908, he came under the influence of mystical and philosophical ideas that dominated his best-known music. He even created a special "mystic" chord that became the harmonic and thematic basis of his later works.

Scriabin's major orchestral compositions are *The Poem of Ecstasy* (1908) and *Prometheus* (1911). However, Scriabin wrote most of his works for solo piano, including 10 sonatas and many preludes and études. His early works show the influence of the Polish composer Frédéric Chopin, but later works moved increasingly away from defined tonality toward modern harmonies. Alexander Nikolayevich Scriabin (sometimes spelled Skryabin) was born in Moscow. Vincent McDermott

Scribe is a person who writes letters, documents, or books by hand. Scribes were especially important in ancient societies in which few people could read or write. Many ancient scribes worked for kings or merchants or as religious officials. Some scribes offered their services to the public in marketplaces. There, they wrote letters or documents for a fee.

Scribes who worked for a king kept tax records, wrote out the king's instructions to government officials, and recorded laws. For merchants, scribes recorded business transactions. For the general public, they drew up contracts and real estate deeds. As religious officials, scribes transcribed sacred literature, among their other duties. In Biblical times, Jewish scribes became teachers and interpreters of laws. The priest Ezra was a scribe. The New Testament includes many negative references to scribes as hypocrites. In the Middle Ages, monks worked as scribes to copy books. Many monks concentrated on *illuminating* (decorating) their manuscripts with intricate designs. See **Book** (The Middle Ages).

Today, scribes still write the scrolls used in Jewish worship. In preparation for this task, scribes must purify themselves by taking a ritual bath. John W. Snyder

See also **Communication** (During the Middle Ages); **Egypt, Ancient** (Education); **Manuscript; World, History of the** (picture: Medieval monks).

Scribe, *skreeb,* Augustin Eugène, *oh goos TAN oo ZHEHN* (1791-1861), was a French playwright. Scribe developed and popularized what is known as the *well-made play.* His formula for such plays included tightly constructed action, suspense, frequent surprises, and reversals of fortune. There was also an *obligatory scene* at the climax in which a secret is disclosed, leading to a logical and satisfying ending.

Scribe was born in Paris. Between 1815 and 1860, he wrote over 400 theater works, including comedies, dramas, opera *librettos* (stories), and light musical satires called *vaudevilles.* His major opera librettos include *Robert le diable* (1831), *The Huguenots* (1836), and *Sicilian Vespers* (1855). Scribe set many of his plays, including *A Class of Water* (1840) and *Adrienne Lecouvreur* (1849), against interesting political backgrounds. But all of Scribe's plays are basically slight, romantic works and are no longer fashionable. However, the well-made play

he pioneered greatly influenced such playwrights as Henrik Ibsen, Arthur Miller, and George Bernard Shaw.

Felicia Hardison Londré

Scripps, Edward Wyllis (1854-1926), was a famous American journalist. Scripps started the first newspaper chain and founded the United Press Associations, now United Press International. He controlled a large number of newspapers and newspaper services.

Scripps was born on a farm near Rushville, Ill. At the age of 18, he started to work on the *Detroit Tribune* as an office boy. In 1878, he began a newspaper of his own, the *Cleveland Penny Press.* This paper was the first of a chain that included papers from the Midwest to the Pacific Coast. Scripps and his brothers bought the *St. Louis Evening Chronicle* in 1880. In 1882, they purchased the *Cincinnati Penny Post,* which they later renamed the *Cincinnati Post.*

Scripps's health failed in 1917, and he gave control of his newspaper holdings to his son, Robert P. Scripps. In 1922, the chain became known as the Scripps-Howard Newspapers, Inc. Joseph P. McKerns

Scripps Institution of Oceanography is a public institution in La Jolla, Calif., for research and graduate instruction in the marine, atmospheric, and space sciences. It also operates ships and marine platforms. It is a part of the University of California, San Diego. The institution's research projects include the study of marine bacteria and plant and animal life; the topography and composition of the ocean bottom; the properties of water, waves, currents, and tides; the interchange of heat and matter between the oceans and the atmosphere; and the dynamics of earthquakes and weather. It was founded in 1903 as an independent laboratory and became a part of the University of California in 1912. It received its present name in 1925.

Critically reviewed by Scripps Institution of Oceanography

Script. See **Television** (Writers); **Theater** (Interpreting the script).

Scriptures. See **Bible; Religion** (Chief characteristics of religion).

Scrofula, *SKRAHF yuh luh,* is a term commonly used for an infection of the lymph nodes in the neck by tuberculosis. Doctors refer to this infection as *chronic cervical tuberculous lymphadenitis.* Lymph nodes are small masses of tissue that help the body fight disease by filtering out bacteria and other material. Much of the filtered material is destroyed in the lymph nodes by white blood cells called *phagocytes.* But some kinds of bacteria, including those that cause tuberculosis, are resistant. These bacteria remain and multiply in the lymph nodes, causing inflammation and swelling. Most cases of scrofula are caused by drinking unpasteurized milk from cows with tuberculosis. Pasteurization kills tuberculosis bacteria, so scrofula is rare in places where milk is pasteurized.

Scrofula occurs most frequently in young children. The infected lymph nodes of the neck swell gradually, and the patient may have no pain, fever, or other symptoms for months or years. Eventually, the infected lymph nodes may break open, releasing pus and causing sores on the neck that remain red and crusty after they heal.

Physicians diagnose scrofula by examining samples of infected tissue under a microscope and by growing bacteria from the infection in a laboratory. Most cases of scrofula can be cured with antituberculosis drugs, such as streptomycin, isoniazid, or rifampin.

Michael G. Levitzky

See also **Lymphatic system** (Lymph nodes); **Tuberculosis.**

Richard Lobell, United Jewish Appeal

A scroll in Judaism serves as the manuscript of the *Torah,* the first five books of the Hebrew Bible.

Scroll is a roll of paper, parchment, or other material, especially with writing or pictures on it. Most scrolls are wound around rods of bronze, ivory, or wood. Sometimes the rods are decorated at both ends with small knobs or other ornaments. The knobs protect the scrolls and make them easier to handle. A scroll is often fastened at both ends so it can be unwound from one rod and rolled up onto the other as it is used.

The Egyptians began using scrolls of papyrus during the 2000's B.C. Beginning in the 1000's B.C., the Hebrews used treated animal skins for their sacred writings because these outlasted papyrus. Later, the Greeks and Romans popularized a way of preparing skins to make a durable writing surface called *parchment.* They pasted together many sheets side by side to form long strips that were wound around the rods. The Chinese and Japanese still use silk and paper scrolls for paintings and writings.

A spiral design, which resembles the end of a loosely wound scroll, appears in Greek and Roman architecture. Ionic columns are decorated with carved, spiral scrolls called *volutes.* Paul H. Mosher

Related articles in *World Book* include:

Bible (picture) Dead Sea Scrolls Papyrus
Book (picture) Manuscript

Scrooge. See **Dickens, Charles** (The first phase).

Scuba diving. See **Skin diving** (Scuba diving); **Diving,** Underwater (Ambient diving).

Sculpin, *SKUHL pihn,* is a family of fishes that have large mouths, large heads, and bodies that taper sharply to the tail fin. They live in many parts of the world in cold water, mostly near rocky shores. Some sculpins live in deep parts of the ocean, and others live in fresh, inland water. Most sculpins have spiny heads and fins and warty skins. People who live in the Arctic regions eat them, although these fish have little flesh and many bones.

Sculpins eat small sea animals and have huge appetites. They often steal the bait from fishhooks. Sculpins are eaten by larger fish.

Scientific classification. Sculpins make up the sculpin family, Cottidae. William J. Richards

Acropolis Museum, Athens, Greece (Art Resource)

Greek gods Poseidon and Apollo (detail)
Greece, 447-423 B.C. Marble.

SCALA/Art Resource

Tympanum of the central portal of Vézelay Abbey
France, 1120's. Stone.

Sculpture

Sculpture is one of the most interesting and complex of the arts. It ranges from Michelangelo's powerful carvings to African masks worn in religious ceremonies, and from stone statues that decorate cathedrals to metal mobiles that sway gracefully in the air.

A piece of sculpture can be small enough to stand on a table, or as large as the Statue of Liberty. But whether large or small, sculpture tends to have a *monumental* quality—the quality of grandeur and nobility in a work of art. Large-scale sculpture is often called monumental because of its size. However, even the smallest piece of sculpture has the power to express noble and grand ideas.

The art of sculpture probably developed in association with religious and magical practices. Sculpture emerged as an art form about 20,000 years ago, during the Paleolithic Period (Old Stone Age). Prehistoric people carved small statues from such materials as bone or ivory. They probably used these carvings in burial or fertility ceremonies. They modeled similar objects in clay. Although the word *sculpture* originally meant *cut* and implied the technique of carving, modeled objects are also called sculpture.

The contributors of this article are M. F. Hearn, Professor of Fine Arts at the University of Pittsburgh; Joseph F. Lamb, Professor of Fine Arts at Ohio University; Louise Lincoln, Curator of African, Oceanic, and New World Cultures at the Minneapolis Institute of Arts; Elizabeth deS. Swinton, Curator of Asian Art at the Worcester Art Museum; and Roger Ward, Curator of European Art at the Nelson-Atkins Museum of Art.

The importance of sculpture

As a record of history. Sculpture is extremely valuable for the information it can supply about the development of human culture. Sculpture can tell us much about the way of life of a particular people or period by physically representing the ideas and ideals of a civilization.

For example, the ancient Greeks and the people of the Middle Ages both idealized the human form in their sculptures and showed the human body as they felt it should look. The Greeks admired humanity and its works, and they tried to make the human form as perfect as possible in such sculptures as the figures of the *Greek gods Poseidon and Apollo* (shown on this page). During the Middle Ages, people were more concerned with life after death than with life on earth. Romanesque sculptors of the Middle Ages made the human form longer and thinner than real men and women in an attempt to create a feeling of spirituality. An example of this highly religious medieval style appears in the long, exaggerated figures in the *Tympanum of the central portal of Vézelay Abbey* in France (this page). The sculptures on the *tympanum,* the area above the portal and under the arch, represent Jesus Christ and the apostles.

In India, China, and other Asian civilizations, sculpture is used to aid contemplation. Such Asian religions as Buddhism and Hinduism stress the eternal, invisible powers of the universe rather than the temporary, observable realities of the everyday world. Through contemplation of sculptured images, Asian peoples seek to

The Stanley Collection, University of Iowa Museum of Art, Iowa City

Ere ibeji figures
Yoruba twin figures. Nigeria, 1900's. Wood and beads. 8 in. (20 cm) high.

Donald Woodman

The Dinner Party by Judy Chicago
United States, 1979. Mixed media. 48 ft. (14.6 m) by 48 ft.

understand these divine powers and to become united with the eternal. Much Indian sculpture is devoted to images of Siddhartha Gautama, known as Buddha, the founder of the Buddhist religion. The *Seated Sakyamuni* (page 236) shows the traditional image of Buddha on a throne meditating in the lotus position. *Sakyamuni* is another title given to Buddha.

Religious ceremonies play an important part in the life of the Pueblo Indians of the American Southwest. The Pueblo people, including the Hopi and Zuni, use carved masks in their rituals. Men wear these masks to impersonate kindly spirits of the earth, sky, and water called *kachinas.* When men wear the masks, they become kachinas. The children receive carved wooden figures called *kachina dolls* (page 244) to educate them about kachinas.

Some modern artists create sculptures that comment on the ideas, ideals, and social issues of their society. The American artist Judy Chicago dealt with feminist concerns in *The Dinner Party* (this page). The work consists of a table with 33 individually designed place settings symbolizing 33 historically important women.

Sculpture also provides us with a record of the everyday life of a particular culture. Because much sculpture is extremely durable, it has survived as a major source of our knowledge about such ancient cultures as Egypt, Babylonia, Mesopotamia, Assyria, and Persia. For example, the *Votive figures* from Mesopotamia (page 235) illustrate the clothing styles of that society.

As monuments and memorials. Because sculpture can be created from such long-lasting materials as stone or metal, it is the art form most suitable for monuments and memorials. This type of sculpture is called *commemorative* sculpture. In some civilizations, most commemorative sculpture represents important people or great events. Notable examples are stone pillars called *stelae* carved by the Maya of Mexico and Central America. A stele was erected in a city plaza (page 243). The Romans created *Trajan's Column* (page 248) as a sculptural record of the Emperor Trajan's victory over Dacia in eastern Europe during the early A.D. 100's.

As artistic expression. Many artists create sculpture to satisfy their creative need to communicate, to express their own ideas and feelings, or simply to create an object of beauty. When we look at a piece of sculpture, we can ask ourselves: "What is the sculptor saying in this work?" or "Why do I find this work beautiful, profound, or disturbing?"

Much modern sculpture is created partly to satisfy the sculptor's desire to experiment with new forms and materials. Many sculptors have been more interested in pure form—that is, the physical shapes of sculptured works—than they are in communicating some idea or theme. For this reason, many modern sculptures are *abstract* or *nonrepresentational,* which means they have no recognizable subject matter. The American sculptor Louise Nevelson constructed *Mirror Shadow VIII* (page 257) of individual wooden components to create a feeling of power and mystery. *Bird in Space* (page 257) shows the interest of the Romanian-born French sculptor Constantin Brancusi in such elements as balance and the treatment of surface.

As part of architecture. Throughout history, sculpture has been closely associated with architecture, partly because similar materials and skills are used in both fields. In the temples of the Middle East, India, and ancient Greece and Rome, and in the cathedrals of Europe in the Middle Ages, the forms of the buildings blend completely into sculpture. This blending can be seen in the heads and bases of columns, the moldings around doors and along the edges of roofs, and the abstract decorations. All these features show that the stonemason's carving skill approached that of a sculptor.

Greek sculptors took particular care in applying sculpture to their temples. They made it blend so well with the architecture that the sculpture was not purely decorative. The Greek sculptors carved their works on panels and *friezes* (horizontal bands) on the sides of these buildings, on *pediments* (triangular segments below a sloping roof), and on *metopes* (square areas above columns).

Occasionally, sculpture that is part of the structure of

Delphi Museum, Delphi, Greece (Erich Lessing from Art Resource)

Charioteer of Delphi
Greece, about 475 B.C. Bronze. 5 ft. 11 in. (1.80 m) high.

a building also performs a function. For example, Greek sculptors made columns in the form of clothed female figures called *caryatids,* which actually hold up part of the building. Many medieval cathedrals have decorated waterspouts called *gargoyles.* The decorations consist of grotesque figures of animals or human beings (see **Gargoyle**).

Sculpture as an art form

Kinds of sculpture. The most familiar kind of sculpture is called *sculpture in the round* or *free-standing sculpture.* It is modeled or carved on all sides. A sculpture in the round can have a main view, giving it a "back" and a "front," as in certain sculptures of the human figure. Or it can be completely finished on all sides so that it can be viewed with pleasure from any angle, as can much abstract sculpture. In the past, some sculpture in the round was meant to be seen only from the front. The artist left the back of the figure rough and unpolished, with tool marks showing. This practice has provided much information about the methods of sculptors of the past.

Sculpture in the round varies greatly in size and scale. Some statues are life-sized or larger. Statues that are somewhat larger than life-sized are said to be in *heroic* scale. If they are from several to many times larger than life-sized, they are in *colossal* scale. Two ancient examples of colossal sculptures were the statue of Zeus in Olympia, Greece, and the Colossus of Rhodes near the harbor of the island of Rhodes. Re-creations of both works appear in the **Seven Wonders of the Ancient World** article.

Sculpture that is completely attached to, or absolutely part of, a flat surface is called *sculpture in relief.* There are two kinds of relief work—*true relief* and *intaglio.* In true relief, the figure stands out from the surface, as in *Lion fighting a bull* (page 234). In intaglio, the figure is carved into the background. The intaglio technique was highly developed by the ancient Egyptians for decorating the massive outside walls of their temples. As used by the Egyptians, it is usually called *low relief.* This kind of relief is best seen in strong light, which makes the outlines of the figures stand out as sharp shadows. An example appears in **Relief** (picture: A low relief).

Relief sculpture can be carved or modeled. Some of the early carved reliefs of the Egyptians are little more than engraved lines on stone. Many Greek reliefs are shallow, but they stand up from a flat surface in true relief. In some reliefs, the Greeks flattened off the forms nearest the viewer, and deeply undercut and rounded the forms at the back. Later Greek and Roman reliefs tend to have the nearer forms rounded, as in painting. The figures seem almost detached from the background, as in the *Alexander Sarcophagus* (page 247).

Reliefs can also be modeled in clay or wax and cast in bronze. Two famous examples of cast reliefs are the doors for the Florentine Baptistery by the Italian Renaissance sculptor Lorenzo Ghiberti, and the new doors for St. Peter's Basilica in Rome by the modern Italian sculptor Giacomo Manzù. See **Florence** (picture: Bronze doors); **Relief** (picture: High-relief figures).

Form and treatment. Sculptors use many elements found in painting. These elements include space, mass, volume, line, movement, light and shadow, texture, and color. But a painting has only two dimensions—height and width—because it is created on a flat surface. The painter can give only an illusion of depth. By contrast, sculptured forms have three dimensions. They have depth, or solidity, as well as height and width because the sculptor creates the forms in space. The terms *mass* and *volume* are used to describe the way sculptured forms occupy space. Mass describes the amount of bulk, solidity, or weight of a form in space. Volume refers to the amount of space occupied by a sculpture. *Line,* or the edges of a sculpture, encloses or defines the shape of the sculptured form.

Movement is an important element of sculpture. Some sculptures seem to be completely at rest and suggest little or no movement. For example, the bronze statue of the *Charioteer of Delphi* (this page) has a simple outline and little detail. It appears powerful, solid, and calm. It stands firmly on its base, in complete balance. This kind of sculpture is called *static* (unmoving).

Sculpture that gives an impression of change, movement, and energy is called *dynamic.* Sculptors can create the illusion of movement in several ways. In *Unique Forms of Continuity in Space* (this page), the Italian sculptor Umberto Boccioni created rhythms within the statue itself through the repetition of curved shapes. The figure seems to hurl itself through space in successive stages of continuing movement. Antoine Coysevox, a French sculptor, showed a figure in vigorous action in his statue of *Mercury* (page 254). When we look at such a figure, our eyes follow the lines of the body and the limbs. These lines lead in many directions, creating a feeling of movement.

Some sculptures actually do move. These works are called *kinetic* sculpture. The first and most original kinetic sculptures were the *mobiles* invented by the modern American sculptor Alexander Calder. As in *Red Petals* (this page), the various elements of most of Calder's mobiles are made of thin sheet metal. Some of them suggest swimming fish or leaves blowing on a tree. The metal shapes are linked by rods and wires to form a series of balanced pairs that are suspended from a single point. They rotate about each other in the lightest breeze.

Some artists build kinetic sculptures in which the various parts move mechanically. The modern French sculptor Jean Tinguely became famous for his complicated structures created out of scrap metal. They have mechanically moving parts that actually break apart, turning the sculpture into scrap once more. The sculpture's "self-destruction" is part of the artist's purpose.

Light and shadow. A painter indicates form by creating light and dark shades. After this shading is completed, it cannot be changed. A sculptor creates an actual three-dimensional object that must depend on changeable natural or artificial lighting. Thus, the sculptor may have a conception of ideal lighting conditions for a particular work. In the case of a commissioned sculpture, the artist may want to study the site where the work will eventually be placed.

The Arts Club of Chicago; WORLD BOOK photo

Red Petals by Alexander Calder
1942. Painted metal and wire. 8½ ft. (2.59 m) high.

Unique Forms of Continuity in Space
by Umberto Boccioni
1913. Bronze.
43½ in. (110 cm) high.

The Museum of Modern Art, New York City; Lillie P. Bliss Bequest

Texture. Because of the natural play of light and shadow, the sculptor also must consider the texture of the forms. The sculptor must decide whether to leave the surface of the work rough, or how far to go in giving it a smooth, highly polished surface. A rough surface, such as one showing the sculptor's hand marks or tool marks, catches light and can give the sculpture a feeling of strength and power. A smooth, highly polished surface can make the work seem impersonal. Compare the French sculptor Auguste Rodin's bronze *Orpheus* (page 255) with the American sculptor David Smith's stainless steel *Cubi XIX* (page 259).

Color. Much sculpture is left the color of its material, whether it is bronze, marble, or wood. Many sculptors and patrons prefer the natural beauty of such materials. However, there is a long tradition of coloring sculpture. To make their works more lifelike, sculptors in ancient Egypt, ancient Greece, and other early cultures naturalistically painted the lips, skin, eyes, and hair of their subjects. Unfortunately, the colors have faded from most surviving sculptures of ancient Egypt and Greece. Many African and American Indian sculptures gain emotional intensity from their coloring. Examples include the *Royal throne* (page 240) from Cameroon and the *Transformation mask* (page 245) from the northwest coast of North America.

Today, many artists use colorful synthetic materials or complete their works with color. An example is *Woman with Suitcases* (page 258) by the American artist Duane Hanson. The work is made of fiberglass and polyester combined with real-life accessories such as luggage and clothing.

Color produces many vivid effects. It can make heavy materials seem lighter, create a happy or gloomy mood,

or make a sculpture resemble a painting created in three dimensions. Complicated forms become easier to understand. The sculptor may also be able to overcome certain difficult lighting conditions.

The sculptor at work

Carving and modeling have been the basic techniques throughout most of the long history of sculpture. In carving, a sculptor works with a solid block of wood, stone, or some other material. The sculptor visualizes the finished figure and then cuts and chips away the material until only the imagined figure remains. In modeling, the artist builds up the sculpture by adding layers of clay, wax, or some other soft, pliable material that will stick to, and blend with, itself.

Because the materials used in modeling are soft, brittle, or otherwise impermanent, most modeled sculpture is turned into a more lasting form. From the earliest times, sculptors have preserved clay figures by baking them until they are hard. Figures made in this way are called *terra cotta,* an Italian term meaning *cooked earth.* Usually, only small figures can be made by this process, and they break easily.

A common way to make a modeled sculpture permanent is to *cast* it in metal or another hard material. First, the artist makes a mold of the modeled work. Into the mold, the artist pours a more permanent material—cement, bronze, or aluminum, for example—and lets it harden. As long as the mold lasts, any number of replicas of the original sculpture can be cast. See **Cast and casting.**

The work of the sculptor today has changed in many ways from previous times. For centuries, sculptors trained as apprentices in workshops. Today, they train in art schools or universities. Most modern sculptors prefer to work alone or with one assistant rather than in a workshop. The work of many sculptors is known primarily through exhibitions at museums and by private dealers. Depending on the materials and the size, creating sculpture in advance can be expensive and risky, because few patrons request specific works. Sculptors often make a *maquette* (small-scale model) to show to buyers. After the artist finds a client, he or she then executes the full-size piece.

Through modern technology, the sculptor has the freedom to choose from a vast number of new materials. Artists commonly use such industrial materials as stainless steel, aluminum, plastics, and neon lights. They also use junk and discarded materials such as old wood or machine parts. The sculptor assembles these materials with glues, power saws, drills, and hammers. Such works are called *assemblages.*

Today, few sculptors carve in wood or stone. Carving is strenuous and time-consuming, and it ties up the sculptor's money in expensive materials. Modeling is much faster, cheaper, and more flexible. Modelers use soft materials such as wax, wet plaster, or clay. Their main tools are their hands, but they also use trimming and shaping devices. Most sculptors make a maquette and take it to a foundry where an enlarged copy is cast in metal under the artist's supervision.

Because of the difficulties of casting, many sculptors work metal by hand. With such modern industrial equipment as electric arc and gas welding tools, an art-

School of the Art Institute of Chicago; WORLD BOOK photo by Ralph Brunke

Modeling. A sculptor builds up a figure with small pieces of clay. A permanent bronze cast will then be made.

School of the Art Institute of Chicago; WORLD BOOK photo by Ralph Brunke

Carving. This sculptor uses a hammer and chisel and other special tools to trim the block of marble to the desired shape.

School of the Art Institute of Chicago; WORLD BOOK photo by Ralph Brunke

Welding is a method of creating metal sculptures through the use of such equipment as arc welding tools.

ist can cut and shape metal and join the pieces together. To finish their sculptures, modern artists use such industrial equipment as sandblasting machines or grinding tools. They can produce a *patina* (surface film) on bronze by applying heat and various chemicals to the finished work.

Beginnings

Prehistoric sculpture. People of the Stone Age thought they recognized the forms of living things in such objects as bones, animal horns, and rocks. Prehistoric sculptors carved eyes or arms and legs in these objects to make them look like people or animals.

There were only a few subjects of prehistoric sculpture, and all of them apparently had some magic significance. The figure of *A bison with turned head* (this page) and other animal sculptures probably represented animals killed by hunters. Figures of a plump woman, such as the *Venus of Willendorf* (this page), may have represented the Mother Goddess, who gave life and food to people.

After prehistoric peoples learned to make pottery vessels by firing clay, they used this technique to make figurines. Terra-cotta figurines have been found in many parts of Egypt, Asia Minor (present-day Turkey), Mesopotamia (parts of modern Syria, Turkey, and Iraq), and the Indus Valley (now Pakistan and western India). Although few details appear on these figurines, prehistoric sculptors obviously did try to emphasize such important physical features as an animal's strong horns or neck, or a goddess's breasts and buttocks.

Musée des Antiquités Nationales, St.-Germain-en-Laye, France, from Art Reference Bureau

A bison with turned head

From the cave of La Madeleine in the Dordogne Valley, France, about 9000 B.C. Reindeer antler. About 4 in. (10 cm) high.

Venus of Willendorf

Willendorf, Austria, 30,000-25,000 B.C.

Limestone. 4 $\frac{3}{8}$ in. (11 cm) high.

Naturhistorisches Museum, Vienna, Austria

Beginning about 3000 B.C., ancient civilizations produced many fine sculptures. By this time, artists had gained skill at working with such harder materials as stone and metals.

Middle Eastern. Most early Mesopotamian sculpture consists of small-scale male and female figures, such as kings, priests, or deities. Sculptors showed their subjects in stiff poses and did not attempt to suggest movement or to portray actual persons. An example is the group of *Votive figures* (page 235) created by Sumerian sculptors of southern Mesopotamia. Livelier scenes of everyday life appear mainly on stone reliefs decorating containers, furniture, and other objects.

During the era of the Assyrian Empire (900's B.C. to 600's B.C.), sculpture was used mainly as architectural decoration. The Assyrians carved colossal stone figures of bulls with human heads to stand beside palace gateways. Palace walls were decorated with reliefs made up of many scenes. These scenes told the story of complete military campaigns and other important events. Some of the finest relief carvings are those from Nineveh (an Assyrian city in what is now northern Iraq), showing a royal lion hunt. Assyrian sculptors carved the movements and forms of animals more accurately and realistically than earlier sculptors did. But their human figures were stiff and unemotional, both in relief carvings and in the few large figures that they carved in the round. See **Assyria.**

Persian sculptors of the Achaemenid Empire, which covered much of the Middle East and southwestern Asia from the 500's B.C. to the 300's B.C., also were interested in the patterns of animal limbs and muscles. An example of their work is the relief *Lion fighting a bull* (page 234). The Persians decorated buildings with large relief sculpture, but their finest work was on a small scale. Some of it shows clear signs of influence from classical Greece. Greek sculptors probably worked for the Persian kings. See **Persia, Ancient.**

The Hittites, who founded a great kingdom in Asia Minor after 2000 B.C., used architectural relief sculpture in a manner similar to the Assyrians. They also carved a number of large monuments from solid rock, showing kings, gods, or religious ceremonies.

Leon Harmon, Photo Researchers

Lion fighting a bull

Relief from the stairway to the Audience Hall of Darius I at Persepolis. Persia (Achaemenid Empire), about 500 B.C. Stone. Figures larger than life-sized.

Aegean. The islanders who inhabited the Cyclades in the Aegean Sea about 3000 B.C. carved figures in white marble. Like the *Cycladic marble figurine* (this page), most of these figures were of women. The sculptors had no metal tools, but they rubbed the figures smooth with pebbles of emery. Archaeologists have discovered most of the figurines in graves.

During the 1500's and 1400's B.C., the Minoans of Crete made superb small figures of worshipers. Some of these figures were made of gold and ivory, and others of terra cotta. Still others were cast in solid bronze. The Minoans did not smooth or polish the bronze, so these figures have a rough finish. The figures show a vigor not developed elsewhere at this early date in history, as can be seen in the bronze figure of a *Woman praying* (this page).

Egyptian. A distinctive style of sculpture developed in Egypt about 3000 B.C. and continued with little major change for more than 3,000 years. Egyptian sculpture was made for limited purposes—to commemorate a person or event or to serve as a substitute for the activities of real persons.

Commemorative sculpture includes *King Mycerinus of Egypt and his queen* (page 235) and other great statues of kings and queens, whom the Egyptians regarded as gods. Some of these statues are colossal in scale. The seated statues of Ramses II, cut in rock at Abu Simbel, are more than 65 feet (20 meters) high. The Abu Simbel statues are illustrated in the **Ramses II** article. Reliefs covering the walls of temples commemorated religious ceremonies or such events as coronations and important military victories.

Egyptian sculptors also carved stone or wooden statues that were placed in tombs to represent the dead. These reliefs and modeled figures showed scenes of daily life similar to the activities the dead were expected to perform in the next world.

In carving the human figure, the Egyptians consid-

Cycladic marble figurine

Cyclades Islands, Greece, about 3000 B.C.

Marble. 30 in. (76 cm) high.

Ashmolean Museum, Oxford, from Art Reference Bureau

Woman praying

Crete, Minoan period, 1500's B.C.

Bronze. $7\frac{1}{2}$ in. (19 cm) high.

Staatliche Museen, Berlin, from Art Reference Bureau

Oriental Institute, University of Chicago; photo by Victor J. Boswell

Votive figures
Sumer, 2700 to 2500 B.C. Stone. Tallest figure 30 in. (76 cm) high.

Museum of Fine Arts, Boston; WORLD BOOK photo by Robert Crandall

King Mycerinus of Egypt and his queen
Egypt (Dynasty IV), 2613-2498 B.C. Schist. 4 ft. 7 in. (1.40 m) high.

ered realistic scale unimportant. They showed a king much taller than his subjects or his enemies. Egyptian sculptors followed fixed rules that controlled the proportions of the parts of the body. These rules applied to sculptures ranging from tiny figures to colossal statues carved out of cliffs.

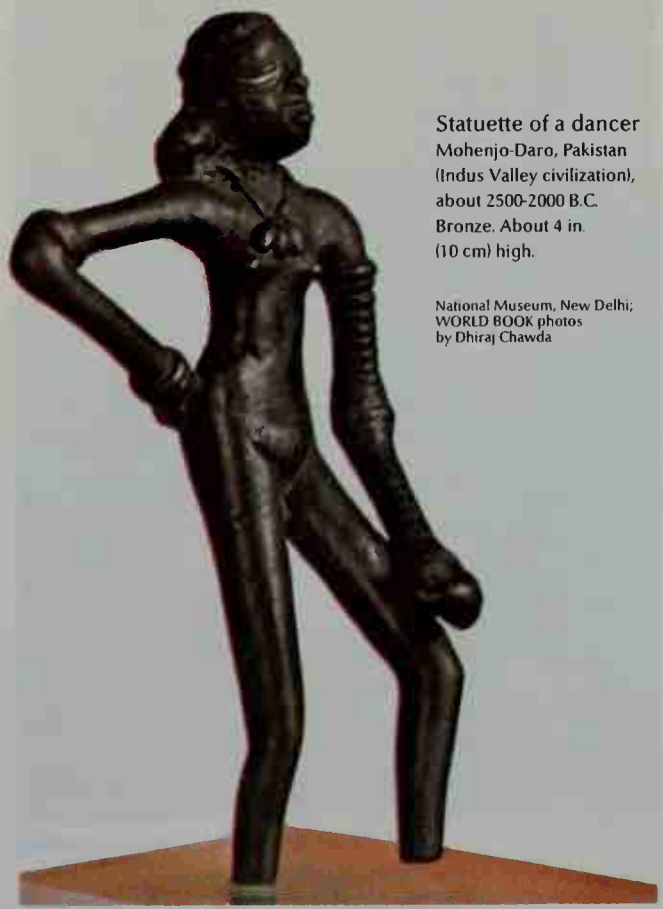
Tradition also required figures to have quiet, restful poses and expressionless faces. The Egyptians considered any vigorous action or realism unnecessary. Only for a short time during the 1300's B.C. did some realism appear in figures and portraits.

Indus Valley. The Indus Valley civilization flourished in what is now Pakistan and western India from about 2500 B.C. to about 1700 B.C. The two main sites of the Indus Valley civilization were along the Indus River—the cities of Harappa in the north and Mohenjo-Daro in the south. Sculptures from these cities include small stone tablets that were used as seals, and figures of animals and human beings.

The seals show the rounded forms of bulls, elephants, and rhinoceroses, along with triangular, curved, and vertical signs. Such seals show the ability of the Indus people to create intaglio—sculpture in which figures are carved into the background—with delicate, curved lines.

The human and animal images were cast in metal, carved from stone, or modeled in clay. Indus Valley sculptors demonstrated a high level of technical skill in all these mediums.

Indus Valley sculptures have a repetition of curving lines that reflects the sculptors' love of linear rhythm. Indus Valley sculpture also stressed harmonized form,



Statuette of a dancer
Mohenjo-Daro, Pakistan (Indus Valley civilization), about 2500-2000 B.C. Bronze. About 4 in. (10 cm) high.

National Museum, New Delhi; WORLD BOOK photos by Dhiraj Chawda

which became a dominant characteristic of later sculpture in India.

Linear rhythm is apparent in the bronze *Statuette of a dancer* (page 235). The sculptor has captured the dancer when she is either pausing after a movement or is just about to move. The dynamic quality of this sleek figure is partly due to the rhythmic, angular thrusts of her arms, legs, and torso. The sculptor has also indicated movement by contrasting the linear rhythms of the torso and legs against the triangular right arm and the forward left leg. This contrast of linear rhythm with square and triangular shapes to produce movement is a characteristic of later Indian sculpture, both Buddhist and Hindu.

Indus Valley sculptors cast objects of copper, silver, and gold. Stone seals and the few surviving three-dimensional stone sculptures represent their subjects realistically and apparently had religious meaning. See **Indus Valley civilization; World, History of the** (picture: A stone seal).

Asian sculpture

Asian sculpture is made up of diverse artistic traditions separated by time and geography. When connections exist in style or subject matter, those connections are usually due to the influence of religion, conquest, or trade. For example, Assyria, Mesopotamia, and Persia—the ancient civilizations of west and central Asia—produced monumental figurative sculpture. After the Muslim conquests of the A.D. 600's, figurative sculpture ceased in these areas because Islam prohibited making images of living things. However, Islamic artists carved reliefs of *motifs* (repeated designs) and *calligraphy* (beautiful handwriting) as architectural decoration. Islamic decorative objects in ivory, metal, and wood have sculptural form.

Until the development of the International Style of modern art in the 1900's, the notion of self-expression in sculpture did not exist in Asia. Traditional Asian sculpture was created primarily to communicate religious and political ideas, for ritual purposes, or to glorify a ruler. Few Asian sculptors are known by name. Sculptors rarely worked alone until the late 1800's. These anonymous artists trained in workshops supported by religious institutions and the ruling classes.

Cleveland Museum of Art, purchase from the J. H. Wade Fund

Seated Sakyamuni

Mathura, India (Kushan period), about A.D. 100. Red sandstone. 20 $\frac{1}{4}$ in. (51.4 cm).

Los Angeles County Museum of Art, anonymous gift

Shiva as Natajara, Lord of the Dance

Tamil Nadu, India (Chola dynasty), A.D. 900's. Bronze. 30 in. (76 cm) high.

India. Some scholars believe that sculpture is India's greatest artistic achievement. Over a period of 4,000 years, Indian sculptors created powerful works characterized by spiritual content and technical brilliance. India's sculptural tradition is primarily based on two religions, Buddhism and Hinduism. However, monumental nonreligious sculpture was sometimes made to glorify a ruling dynasty.

Sculpture first flourished in India in the 2000's B.C., and that period is discussed in this article in the section *Indus Valley*. The beginning of traditional Indian sculpture can be dated to the 300's B.C. and the establishment of empires that ruled most of south Asia. The influence of the sculptural style of Persepolis, the Persian capital in what is now Iran, may have played a role in developing the high artistic level of Indian sculpture as early as the 100's B.C.

A sculptural style emerged in India that spread across Asia with Buddhism and through Hindu traders and merchants. This style was stimulated by religious doctrine, particularly the *bhakti,* or worship, cults. These cults required narrative reliefs of Buddhist legends as well as ornamental imagery to decorate both nonreligious and monastic religious sites.

Museum of Fine Arts, Boston, gift of Denman Waldo Ross in memory of Okakura Kakuzo

Seated bodhisattva
China, A.D. 530. Limestone. 77 $\frac{1}{4}$ in. (196.2 cm)

From about the 100's B.C. to the A.D. 500's, sculptural activity flourished due to the construction of many temples and other religious structures and the support of royal patrons. This sculpture represented spirituality through the appeal of the human body. Buddhist art dominated this period. Folk gods and goddesses incorporated into Buddhism were represented on the gates and stone railings of *stupas* (funeral mounds). Stupas contained relics of Buddha and were also symbols of the universe.

Buddha was not represented in human form until the period from A.D. 1 to 99. Images such as the *Seated Sakyamuni* (page 236) express Buddhist teaching in a visual form. The sculptor communicates ideas through the image's physical characteristics, gestures, dress, and surrounding figures. A workshop in the city of Mathura, India, carved this work. The same workshop probably also made images for Hinduism and the Jain religion. Some Mathuran Hindu deities produced about the A.D. 100's already have multiple arms, a common feature of the art of later periods.

The Buddha image also appeared before A.D. 100 in Gandhara in present-day Pakistan. Gandharan Buddhist images are based on models from Greece and Rome and are more realistic than those produced in central India.

The 400's and 500's marked a classical phase in Indian sculpture followed by a long period in which styles changed at a slow pace. Sculpture of this later period, sometimes called *medieval,* is dominated by Hindu images. Stone and bronze images reveal the increasing importance of rules and rituals in making sculpture. Bronze works express, through their smooth surfaces and rhythmic lines, philosophical ideas about existence. Borrowing from the language of Indian dance, sculptors created works that rise above ordinary human activity and express profound religious truths. A common theme shows the Hindu god *Shiva as Natajara, Lord of the Dance* (page 236). Many other works show the god Vishnu in various forms. See the pictures with **Vishnu; Gupta dynasty; India** (The arts).

The Indian influence. Traders and missionaries carried Indian culture throughout Southeast Asia as well as to such Himalayan kingdoms as Nepal and Tibet. The great temple complexes of Borobudur in Indonesia and Angkor in Cambodia were heavily decorated with reliefs and with images in the round. These sculptures developed in response to the fervent worship of Buddhist and Hindu deities imported from India.

Borobudur (page 238) was a great monastic and pilgrimage site. Its temple complex resembles an architectural mountain and was created to symbolize the Buddhist universe. Sculptures at the site, carved in dark-colored volcanic stone, express serenity and harmony in their treatment of the human body. See **Angkor; Architecture** (picture: Angkor Wat); **Indonesia** (picture: Borobudur).

Metropolitan Museum of Art, New York City

Kneeling archer
From the tomb of Shi Huangdi. China (Qin dynasty), 221 to 206 B.C. Terra cotta.

© David Ball, The Stock Market

Borobudur
Temple complex showing seated Buddha. Indonesia, late 700's-800's. Stone.

China. During the Neolithic Period (about 8000 B.C. to 3000 B.C.), sophisticated ceramic vessels with painted, inscribed, or applied decoration appeared throughout what is now China. These containers apparently were ritual vessels.

During the Shang dynasty (about 1766 B.C. to 1122 B.C.), skilled craftworkers used a new medium—bronze. But Shang bronzes retained the forms and functions traditionally associated with pottery. The vessels were produced by a unique process called the *piece-mold method.* Artists made models of clay and then a clay mold of the modeled work, into which bronze was poured. The outer mold was made of separate pieces rather than a single unit. Because the mold had to be destroyed to free the vessel, the object could not be duplicated. See **World, History of the** (picture: A bronze ceremonial vessel).

Shang dynasty sculptors made elaborate bronze vessels for rituals of ancestor worship. Realistic and stylized motifs of human images and animals decorate these ritual containers. The animal motifs include buffaloes, serpents, dragons, and tigers. Bronze vessels for wine and grain were made in fantastic shapes with beautiful surface patterns. These vessels dominated Chinese sculpture from the Shang dynasty to about 200 B.C. Sculptors also worked in stone, bone, jade, ivory, clay, and wood during this period. For examples, see **Bronze; China** (pictures: Chinese ceremonial art).

The life-sized figures in the tomb of Emperor Shi Huangdi near Xi'an, China, reveal monumental figure sculpture in China at least as early as the 200's B.C. An example is the *Kneeling archer* (page 237). See also **Archaeology** (picture: An army of life-sized statues).

Interaction with other cultures, including Buddhism, during the Han dynasty (202 B.C. to A.D. 220) influenced the art of China. During the period called the Six Dynasties (A.D. 220 to 589), Chinese sculptors transformed the swelling, round forms of Indian rhythmic carvings into two-dimensional linear carvings in stone and bronze. Deities once portrayed as nude were clothed and their facial features simplified. In east Asian Buddhism, spiritual leaders called *bodhisattvas* became the focus of popular devotion. A bodhisattva is an individual who puts off personal salvation to help humanity. The *Seated bodhisattva* (page 237) is dressed in the fine clothes of a prince. His body has disappeared beneath ribbonlike scarves and cascading drapery. The statue follows the conventions of Indian Buddhist sculpture, but the Chinese artist changed the way the figure is portrayed. See **Asia** (picture: Asian art); **China** (pictures: Chinese sculpture).

The Tang dynasty (618-907) carried the International Style of Buddhist art to central Asia and Japan. Tang sculpture became renowned for its realism. Buddhism ceased to be a major artistic force in China by the Yuan dynasty (1279-1368), and sculptural styles became static. Sculptors created small decorative works in ceramics, wood, and jade and other semiprecious stones in a style that continued with little variation to the 1900's.

Korea. Metalworking and advanced ceramic artistry in Korea were heavily influenced by China. Early Korean sculpturelike objects include golden crowns and stoneware vessels from the A.D. 400's and 500's, and porcelains from the 1000's and 1100's. The image-making tradition of Buddhist art inspired monumental figure sculpture in Korea.

The first Buddhist sculptures came to Korea from China, but by the 500's, local sculptors were producing works based on Chinese models. By the 600's, a distinctive Korean sculpture style had emerged in which delicacy and elegant curved rhythms indicate tranquility and repose. Examples include sculptures found in the Sokkulam cave temple near Kyongju and the gilt bronze *Buddhist triad* (this page) excavated from Anap-chi Kyongju. Both are monuments to the International Style of Buddhist art, a realistic style that flourished in the late

Kyongju National Museum, Korea

Buddhist triad
Excavated from Anap-chi Kyongju, South Korea, late 600's-700's. Bronze.

600's and 700's. The full modeling of the figures and the lotus throne reveal the importance of Buddhism for east Asian sculpture. See **Religion** (picture: A Buddhist).

Japan. The Jomon, an early Japanese culture of the Neolithic Period, made expressive vessels and figurative sculpture in clay. By the A.D. 200's, Japanese metalworkers cast ritual bells and decorated mirrors in bronze. Sculptors also made clay figures of human beings and animals, called *haniwa,* as funeral art for members of the ruling classes.

The introduction of Buddhism in the mid-500's brought the advanced culture of the Asian mainland and a developed sculptural tradition to Japan. The early centuries of Japanese art history reflect a reworking of artistic styles developed in China and Korea. Korean sculptors who moved to Japan produced some of the early masterpieces of Japanese sculpture. One of these sculptors was Tori Busshi, who worked during the early 600's. Japanese sculpture refined a style developed on the Asian mainland. However, even under the cultural domination of China, Japanese sculptors created works of great sophistication and beauty.

In response to the realism of the International Style of Buddhist art, a new style of Japanese sculpture arose in the 800's. Sculptors carved images from a single block of wood, and the resulting figures emphasized the block from which they were cut. These figures had massive proportions, heavy thighs, thick facial features, and deeply cut drapery.

By late in the Heian period (794-1185), sculptors responded to the current taste for courtly elegance and refinement. The work of the sculptor Jocho and his studio created the model for subsequent Heian period sculpture. Jocho used a new technique of assembled or joined wood-block construction. He created an idealized style of elegant proportions. Other sculptors of the Heian period represented deities of Japan's traditional Shinto religion in painted wood.

Jocho, who died in 1057, ended the tradition of the anonymous sculptor in Japan. In the succeeding Kamakura period (1185-1338), individual sculptors and their schools became increasingly important. The Kamakura period was the great age of Japanese sculpture. Kamakura sculpture appealed directly to ordinary people and was conservative in style. Portrait sculpture of both real and imaginary subjects, and images of minor deities, exhibit the full power of the new style.

Works by the great Japanese sculptor Unkei, who died in 1223, reveal a realistic technique that characterizes his style. One of Unkei's masterpieces is his imagined portrait of the Indian holy man *Asanga* (this page). The statue is also called *Muchaku* in Japanese. The realistically painted wood is deeply carved to suggest the weight of real fabric. Unkei individualized the figure's features and emphasized the bone structure and muscles. The tension in the face and hands suggests vitality. See **Bell** (picture: Japanese temple bell); **Buddhism** (picture: The *Daubutsu* Buddha); **Ivory; Japan** (picture: Shinto and Buddhism).

African sculpture

The peoples of Africa have created an immense variety of sculpture. The materials, purpose, and meaning of the sculpture vary according to the peoples' ways of life and thought. Settled agricultural peoples have a long tradition of sculpture in wood, clay, metal, stone, and ivory. However, nomadic African peoples who live primarily by hunting or keeping herds of animals have created virtually no large sculpture.

Outside of Egypt, the earliest known African sculptures are terra-cotta heads and figures from the Nok civilization in present-day Nigeria. These works date from about 500 B.C. Archaeologists are finding evidence of

Hokuen-do, Kofukuki, Nara, Japan

Asanga by Unkei
Japan, 1208. Painted wood. Life-sized.

early sculptural traditions elsewhere in Africa as well.

To Westerners, traditional African sculpture sometimes seems strange and difficult to understand. Until the 1900's, Western sculpture emphasized realism. Some African sculptors have shared this interest, but most have deliberately distorted form for expressive purposes. It is important to note that African sculptors were not trying to achieve an accurate surface representation of their subject. Instead, they wanted to produce a visual and emotional response, such as respect, fear, or pleasure. Over time, distinctive regional styles developed that emphasized these characteristics.

Because wood, widely used as a material, decays quickly in tropical climates, little African sculpture survives from before the 1800's. At that time, European missionaries and colonizers recorded aspects of traditional African life and brought works of art in increasing numbers to the West. The coasts and river basins of the western part of the continent had the most European contact. As a result, the art of these regions is the best known outside of Africa. However, artistic traditions elsewhere in Africa are also highly developed.

Royal and public sculpture. Certain regions in Africa grew wealthy through trade by about A.D. 1000, and complex societies developed that included kingship and elaborate court life. By the 1400's, vast empires south of the Sahara had prospered from control of gold, ivory, and other precious materials. Artists made sculptures, as well as other art forms, to represent and enhance the authority of kings. Their works included portraits of rulers, accounts of mythical or historical episodes, and highly decorative thrones that are closer to sculpture than to furniture. An example is the *Royal throne* (this page) from the palace at Foumban in Cameroon.

Pigorini Museum, Rome

Guardian figure
Kota people, Gabon, 1800's. Metal. 17 in. (43 cm) high.

Detroit Institute of Arts, Founders Society purchase, Eleanor Clay Fund for African Art

Nkisi
Kongo people, Congo (Kinshasa), 1875-1900. Wood with screws, nails, blades, and shell. 46 in. (117 cm) high.

Museum für Völkerkunde, Berlin

Royal throne
Bamun people, 1800's. From the palace at Foumban, Cameroon. Wood decorated with beads.

Today, some African sculpture still is made for public display. Some works play important religious and social roles. For example, in Congo (Kinshasa), Kongo people and their neighbors seal oaths and settle legal disputes by driving blades or nails into a large male figure. This figure, called a *nkisi* (this page), is the residence of powerful spirits. Over time, such a figure becomes a kind of historical record for its village. The materials, facial expression, and pose of nkisi figures show their power.

African dance masks are also made for public display. In the Western world, such masks are generally hung on a wall and admired for their form. In Africa, however, the mask is one of several elements in a dance costume and is usually seen in motion. In African villages, masked dancers appear on a number of public occasions. They celebrate harvests, welcome back boys and girls who have gone through religious initiation, and participate in funeral ceremonies. Most masks represent standard characters from myth or folklore and are widely recognized by the audience. The performance of the dancers is often meant to demonstrate both acceptable and unacceptable behavior, and thus reinforce social and moral values. A *mask* by the We people of the Ivory Coast is shown on page 241.

People in Igbo villages in Nigeria sometimes build mud sculpture displays called *mbari houses* as a way to educate young people and remind everyone of com-

mon Igbo cultural expectations. Inside each house are dozens of brightly painted figures, many of them life-sized. They show scenes of normal life next to mythic, outrageous, or sexually explicit images. The displays have a moral purpose. They tell stories in which the good are rewarded and those who behave in an unacceptable way are punished. A *mbari shrine* dedicated to the earth goddess Ala is shown on this page.

Personal sculpture. African artists also make much sculpture for the everyday use of common people. Sculptors often create such useful objects as cosmetics boxes and combs. They even carve decorative geometric designs and tiny animals or human figures on pulleys that are part of weaving looms.

Some personal sculpture has a religious purpose, sometimes to commemorate a death. Twin births occur frequently among the Yoruba of Nigeria. If a Yoruba woman gives birth to twins and one baby dies, she cares for a small wooden figure in memory of the loss. These figures, called *ere ibeji* (page 229), are a well-known form of African art in the non-African world. Men in Gabon keep the bones of ancestors in a basket or box guarded by a spirit figure or highly abstract head, often made of wood and covered with metal. One such *guardian figure* is shown on page 240. Ijaw people of Nigeria remember their ancestors with an elaborate three-dimensional memorial screen that depicts the deceased.

African sculpture today. Male artists still make most African sculpture, both for traditional uses and to sell to tourists. The artists learn their skills through an apprenticeship system, studying with an older sculptor until they master the techniques of their art. During the European colonial period, Western ideas about education were introduced into Africa. Many African schools and universities now provide art education similar to that in Europe and North America. As a result, many studio-trained artists, both male and female, produce work more closely resembling that of Western artists. However, the African sculptors often incorporate traditional images or themes into their works.

For additional examples of African sculpture, see **Africa** (The arts); **Mythology** (African mythology).

Seattle Museum of Art, gift of Katherine White and the Boeing Company

Mask

We people, Ivory Coast, 1900's. Wood, raffia, cloth, teeth, mirrors, wax, and mud. 31 $\frac{7}{8}$ in. (81 cm) high.

Photo © Herbert Cole

Mbari shrine

Featuring the Igbo goddess Ala. Owerri township, Nigeria, 1964. Mud.

Pacific Islands sculpture

Artists of the Pacific Islands have produced sculpture in an astonishing variety of materials, including wood, wicker, stone, ceramics, barkcloth, tortoise shell, dog's teeth, and cobwebs. Many kinds of Pacific sculpture have undergone change in the last 100 years as European tools and materials became available to sculptors, and as ways of life altered.

Although Pacific artists frequently make the human form their subject, they are generally not concerned with producing a realistically proportioned or modeled image. They are even less interested in creating portraits of individuals. For the most part, sculpted figures represent supernatural beings, such as spirits, deities, or deceased ancestors. Thus a close copying of human anatomy is not the artist's goal. The expressive qualities of the sculpture are of far greater significance. The Pacific Islands are grouped into three main regions: (1) Micronesia, (2) Polynesia, and (3) Melanesia.

Micronesia. In the tiny scattered islands of Micronesia, people have not made much three-dimensional art. However, in the central region of the Caroline Islands, artists made masks and massive, highly abstract wooden figures until the early 1900's.

Polynesia has developed a great number of sculptural traditions. In earlier times, the region had dense population centers and highly developed political and religious leadership. As a result, a specialized class of artists emerged. Much of their work was meant to demonstrate the rank and status of their patrons.

Before the arrival of Christian missionaries, Hawaiian

Menil Collection, Houston (Hickey-Robertson)

Maori post figure
New Zealand,
Wood, 14 $\frac{1}{2}$ in. (36.8 cm) high.

temples were filled with heads and figures, often more than 6 feet (1.8 meters) high. They were made of wicker or wood and represented deities. Some were ornamented with feathers, teeth, or shells. Artists also made smaller sculptures and decorative arts, such as cooking utensils, in a similar style, showing a shortened body and dramatic grimacing face. For an example, see **Mythology** (Mythology of the Pacific Islands).

Maori sculpture of New Zealand ranges in size from large carved architectural panels for assembly houses to small jade pendants called *hei tiki.* Because Maori religious tradition placed many restrictions on the making and use of sculpture, artists had to be highly educated in religious as well as artistic ideas. Scholars believe most figures represent honored ancestors. Lively curved surface decorations reproduce patterns formerly tattooed on the skin. An example is the *Maori post figure* on this page.

Easter Island is the site of colossal stone heads shaped from volcanic rock. Most of the heads probably date from between the 1100's and 1600's. However, scholars still debate their use and meaning. See **Easter Island.**

Melanesia is one of the most culturally diverse regions in the world, and this diversity is reflected in its art. Melanesian sculptors, primarily men, make human figures, mythical beings, and animals. They also produce masks for occasions ranging from harvest festivals to funerals and initiation ceremonies. Some sculptures are made for public display, but others are kept inside houses that are forbidden to anyone but initiated males. For example, in many villages along the Sepik River in New Guinea, men make large wooden figures for public view. They also carve smaller ceremonial objects, as well as drums, canoe prows, and large decorated hooks for storing food and possessions inside houses.

In many regions of Melanesia, public sculpture is thought of much as it is in the West. Works are commissioned by patrons, and artists are widely known by name. On the island of New Ireland, in Papua New Guinea, families commission sculpture groups at great expense for memorial ceremonies called *malagans.* The sculptures, like the one on this page, are complex combinations of images of human beings, animals, and dazzling patterns that have profound meanings. The display is arranged, discussed, and admired, but then the works—also called *malagans*—are discarded and allowed to decay. The right to make a particular sculpture can be inherited or sold. Because the owners remember its appearance, they can commission a new version for special occasions.

Indian sculpture of the Americas

Knowledge of the sculptural traditions of American Indians will always be incomplete. In many regions, Native American sculptors worked mainly in wood and other perishable materials, which disintegrate over time. Even sculptures made of durable materials have been destroyed by forces of nature or human activity. Because looters often plunder archaeological sites, the primary source for information, scholars may have difficulty determining the age and origin of surviving objects. In spite of so much missing evidence, however, it is still possible to form a general picture of the Indian sculpture of North, Central, and South America.

Early sculpture. Although people in the Americas created sculpture earlier, the oldest well-defined sculptural traditions known thus far are those of the Olmec and the Chavin. The Olmec people lived in Mexico, and the Chavin culture thrived in Peru. Both cultures developed in the centuries before 1000 B.C. They emerged with the development of agriculture, the beginnings of towns and cities, and the rise of specialists in art and religion.

Olmec artists produced human figures in ceramic and jade. Many of these works show the facial features of the jaguar, an animal that often appears in Mexican and Central American art. The Olmec also made a variety of

Field Museum of Natural History, Chicago

Malagan image
Northern New Ireland, Papua New Guinea, early 1900's.
Painted wood, 66 in. (168 cm) high.

architectural sculpture, such as reliefs on buildings that show human and religious subjects. Perhaps the most spectacular Olmec works were their colossal stone heads, which historians assume had religious significance. An example of an Olmec stone head is shown on this page.

Chavin art, though smaller in scale than Olmec works, shows a similar high level of technical accomplishment. A Chavin *Bowl in the form of a jaguar* (this page) is an example. In addition to works in stone, ceramics, and shell, Chavin artists also sculpted in gold.

About the time when Olmec and Chavin art was developing, a tradition of sculpture was forming farther north. In the southern Mississippi Valley and eastward, Indians produced small stone sculptures that archaeologists call *bannerstones* and *birdstones*. The stones are

University Museum, Philadelphia; WORLD BOOK photo by Robert Crandall

Bowl in the form of a jaguar

Peru (Chavin style), about 1200-400 B.C. Stone. 6 $\frac{1}{2}$ in. (17 cm) high.

weights for a device called an *atlatl* that permits a spear to be thrown a greater distance. However, most of them show little signs of use. The objects were probably made to display the prestige of their owner, to be exchanged, or to honor the dead.

Later Indian sculpture. Although Native Americans seem to have made small-scale sculpture in clay continuously throughout much of Central and South America, more ambitious traditions developed with the rise of cities. In urban areas, artists most often worked in the service of political or religious authorities. The Maya succeeded the Olmec in southern Mexico and Guatemala. The Maya continued the production of large-scale stone architectural sculpture. They erected stelae in their city plazas to commemorate Maya rulers or deities or historical events and ceremonies (this page). Maya artists also made smaller items in jade, stone, and ceramics. See Maya (pictures).

Museo Jalapa, San Juan, Puerto Rico; photo by Art Resource

Olmec head

800 B.C.-A.D. 600. Stone. Over 9 ft. (2.7 m) high.

Detroit Institute of Arts; photo by Dirk Bakker

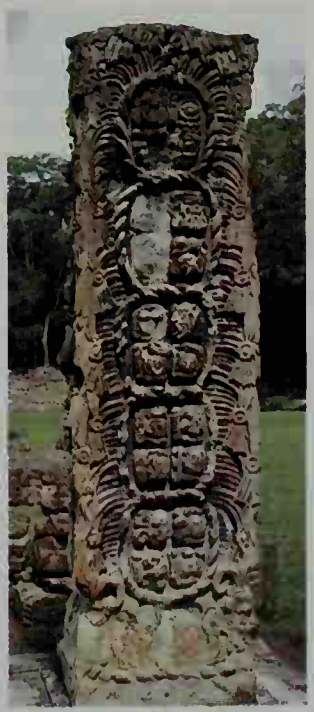
Metate (corn-grinding platform)

Costa Rica, A.D. 1-500. Stone. 18 in. (46 cm) high.

In what is now Costa Rica and Nicaragua, artists produced sculptures in many materials—ceramics, cast and hammered gold, jade, and stone. Among their most spectacular creations are stone sculptures in the form of *metates* (corn-grinding platforms). Indians throughout Central and South America made and used simple stone metates, and the platforms continue in use today. However, many elaborate versions show no signs of wear (this page). They may have served as symbols of authority, indicating control of the process of transforming corn into food.

In Peru, artistic expression flourished most dramatically in ceramics, principally in spherical pots that often were made in human or animal form. Most were apparently made as *grave goods,* which were items buried with a dead person. Some of the more complex examples were formed in clay molds. The most famous of these are the Moche portrait jars from the northern coastal area, depicting detailed faces or crouching figures.

The west coast of Mexico was home to another highly developed tradition of ceramic sculpture. From about 300 B.C. to A.D. 200, sculptors produced a large number of pottery figures for use as grave goods.



Ruins of Copan, Honduras, © Justin Kerr

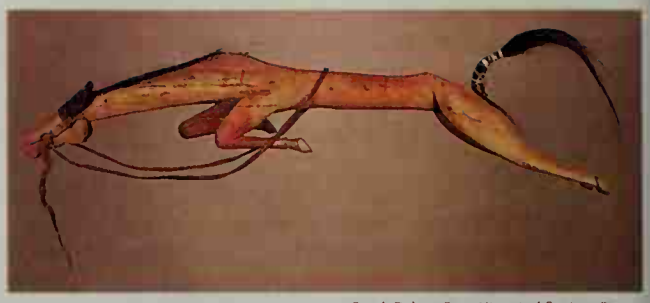
Maya stele

About A.D. 800. Stone. 6 ft. (1.8 m) high.

Colorado Springs Fine Art Center

Zuni kachina doll

United States, 1900's. Wood, cloth, feathers, and hair. 19 in. (48 cm) high.



South Dakota State Historical Society, Pierre

Dance stick

Lakota effigy in the form of a horse. United States, 1884-1910. Painted wood with leather ears and reins. 37 $\frac{1}{4}$ in. (94.6 cm) long.

The sculptures portray human beings, animals, and even vegetables, as well as scenes of figures in houses or performing ceremonial dances. These pieces provide much information about clothing and ways of life. Some of their stylistic characteristics—such as extremely short, thick legs—were determined by the technical requirements of making large ceramic pieces.

Increasing trade and contact throughout the Americas helped the development of urban centers outside Central America. In south and southeastern North America, towns and cities began to develop, especially in the southern Mississippi River Valley. These urban areas were never as large or as wealthy as the great cities of Mexico or Peru. As a result, they did not produce the ambitious architectural sculpture of the southern regions. However, artists did work on a smaller scale in wood, stone, clay, and metal. Much of their work, such as representations of human heads and figures, probably had religious or political purposes. Some sculpture, such as pipes, was made for personal use.

The European impact. The arrival of Europeans at the end of the 1400's brought catastrophic change to the lives of the original inhabitants of the Americas. Many Indians died in battles or from diseases the Europeans introduced. In Central and South America, earlier forms of social organization were replaced by Spanish colonial rule and especially by the influence of the Roman Catholic Church.

The Europeans suppressed or destroyed many local artistic and religious traditions, but others evolved into new forms. For example, Indians in Mexico wore masks in ceremonies. These ceremonies were transformed into the festivals of the Christian church calendar. Wooden masks, which are still made in many Mexican towns, combine ancient elements with images of saints or Biblical characters.

In what is now the United States, the experience of Native Americans in dealing with Europeans was more varied. In the Southwest, Indian religious traditions survived best among remote or culturally closely knit peoples such as the Pueblo Indians, including the Zuni of New Mexico and the Hopi of Arizona. Pueblo sculptors make the well-known *kachina dolls* (this page). These dolls are actually models of spirits called kachinas in ceremonial dance costumes. The dolls are made for their original purpose of teaching children about kachinas. Artists also sell the dolls to outsiders. See **Kachina** with its list of related articles.

The Indians of the eastern coast of North America lost much of their traditional way of life after Europeans arrived. Colonists from northern Europe constantly forced the northeastern Indians westward, with little regard for their survival. As a result, much of their culture has been lost. Scholars do know that in precolonial times people of the Eastern Woodlands made pipes and small figures of stone and clay. They also carved wood, but little has survived. Notable exceptions are the religious masks in wood or twined fiber made by the Iroquois Indians in New York. The masks represent supernatural beings and are used in healing ceremonies.

In the center of North America, the Plains Indians retained more of their cultural traditions. However, their nomadic way of life made only small sculptures practical. In Plains religions, the pipe is a sacred instrument. Plainsmen made pipe bowls from stone or wood. By the 1800's, they often adorned these bowls with elaborate figures. The wooden pipestems were often decorated in high relief, pierced with patterns, or carved in twisted forms. Most Plains sculpture was created in wood, such as the *Dance stick* carved in the form of a galloping horse (this page) used in ceremonial dances. Other sculptures included feast bowls, spoons decorated with animal motifs, and elegant flutes that ended in bird heads.

Thomas Burke Memorial Washington State Museum

Transformation mask

Kwakiutl tribe of the Northwest Coast of North America, 1896. Cedar, commercial paints, and metal hinges. 56 in. (142 cm) long.

The Indians of the Northwest Coast of North America have perhaps the most elaborate sculptural tradition. There, wealthy families commission a wide variety of objects, including carved spoons and enormous totem poles, to enhance their prestige (see **Totem**). Virtually every work of art of the Northwest Coast peoples includes animal themes that refer to mythical stories and clan identity. Many carvings are painted, and some are inlaid with bits of shell or metal. During long winter nights, masked and costumed dancers present elaborate theatrical productions. Many dancers wear *transformation masks* (this page) that can be opened, spread out, or changed from one character to another.

On the Northwest Coast and elsewhere, many Indian artists are working to preserve their culture, and they make objects in the traditional way. Other artists, however, acknowledge that their world has changed, and they reflect that development in their work. It might be a relatively small change, such as using commercial paint instead of natural pigments. It also may be a major change, such as making tiny sculptured boxes in precious metals instead of the traditional large carved wooden chests. Some Indian artists produce work that cannot be distinguished from that of other modern artists in Europe and the Americas. For additional examples of Indian sculpture, see **Indian, American**.

Greek sculpture

Early Greek sculptors made simple, formal works. They gradually learned to make realistic figures and to indicate emotion by facial expression or bodily pose. This was the style copied by Roman sculptors and relearned by Renaissance sculptors. It served as the basic style for European sculpture until the late 1800's.

There were three major periods in the development of Greek art: (1) The Archaic period dated from about 630 to about 480 B.C. (2) The Classical period lasted until about 323 B.C. (3) The Hellenistic period ended about 146 B.C.

Archaic sculpture. In the 700's B.C., before the Archaic period, artists knew how to make only small figures of clay or bronze. However, they also may have carved wooden statues. During the 600's B.C., they began making clay figures in molds. The Greeks learned this technique from the Phoenicians and other peoples of the East. Archaic sculptors developed a rigid and Eastern-looking style called *Dedalic,* which they also used in carving small limestone figures.

At the end of the 600's B.C., the Greeks learned from the Egyptians how to make larger statues and how to carve harder stone—their own white marble. From then until about 480 B.C., the Greeks perfected their carving techniques and gradually succeeded in making figures that were more lifelike. They carved many standing figures of naked male youths. These figures, called *kouroi,* served as attendants to the temple of a god, or as memorials over tombs. Similar carvings of clothed maidens were called *korai.* The frontal pose and calm expression of the *Kore* on page 246 show how much the Greeks improved on Egyptian work. Livelier figures appeared in reliefs on temples and treasuries, as in the *Battle of the gods and giants* (page 246).

Classical sculpture. After Greek sculptors learned to show the human body accurately, they paid more attention to drapery. In early classical works, drapery hung straight and rather stiffly, as in the *Charioteer of Delphi* (page 230). In later works in the period, the garments hung in deeply cut folds. Finally, classical Greek sculptors showed drapery clinging to the body or blowing free from it.

The Greeks thought of their gods as being like people, and sculptors portrayed gods as people in such works as the Apollo Belvedere (see **Apollo**). They showed people as godlike beings. Even after sculptors began to make portraits of real persons, they idealized the faces.

The high point of the classical style is generally considered to be the sculptures on the Parthenon in Athens. They were created after the mid-400's B.C. These sculptures celebrated the city's pride and the Greeks' defeat of the Persians in 480 and 479 B.C.

During the 300's B.C., sculptures of the human figure

showed some emotion and vigorous action. For the first time, some sculptors' artwork showed goddesses nude. Lysippus made heavily built figures of athletes. Praxiteles specialized in a softer, flowing style in his figures of gods and goddesses. Sculptors decorated *sarcophagi* (stone coffins) with reliefs. A good example of such a relief is the *Alexander Sarcophagus* (page 247). Portrait sculpture also began during the classical period. Lysippus was perhaps the first to draw the viewer closer to the work of art by making movement in the piece more complex.

Hellenistic sculpture. The conquests of Alexander the Great carried Greek culture into Egypt and the lands of the East. After Alexander's death in 323 B.C., his empire was split into smaller kingdoms. In these kingdoms, the courts encouraged local schools of art. The most important of these schools were at Rhodes, Pergamum, and Alexandria. Artists blended local ideas with Greek standards of beauty. The result was a colorful art called *Hellenistic*.

Athenian artists continued to follow a more classical style, but Hellenistic sculptors preferred to create works in active, dramatic poses. Some subjects were portrayed showing violent feelings and lifelike actions. An example appears in the **Laocoön** article. Many Hellenistic figures were much less idealistic than were earlier works. For example, in the *Statue of a seated boxer* (page 247), the sculptor showed a boxer's broken nose. For more information about Greek sculpture, see **Elgin Marbles; Lysippus; Parthenon; Phidias; Praxiteles; Venus de Milo; Winged Victory.**

Acropolis Museum, Athens, Greece, Art Resource

Kore 675

Greece (island of Chios), about 520 B.C. Marble. 30 in. (76 cm) high.

Etruscan and Roman sculpture

Etruscan sculpture. The Etruscans probably came from what is now Turkey. They migrated to Etruria (present-day Tuscany, Umbria, and Latium) in central Italy about 800 B.C. They learned sculpture from Greek artists who settled in Etruria, and from Greeks living in neighboring colonies in southern Italy and Sicily.

The Etruscans specialized in bronzes and in terra-cotta works, which they painted in bright colors. Some of the best Etruscan terra-cotta sculptures are four life-sized statues, including one of the god Apollo. These statues stood on the roof of a temple at the ancient

Delphi Museum, Delphi, Greece, Art Resource

Battle of the gods and giants

Detail from the north frieze of the Treasury of the Siphnians at Delphi, Greece, about 525 B.C. Marble. 26 in. (66 cm) high.

Archaeological Museum, Istanbul, Turkey; SCALA/Art Resource

Alexander Sarcophagus (detail)
Relief showing a battle scene, from a coffin made for a ruler of Sidon. Phoenicia, about 323 B.C. Painted marble. Frieze 23 in. (58 cm) high.

Etruscan city of Veii northwest of Rome. Sculptors seldom achieve figures of this size in clay, even today.

Etruscan sculptors also carved works from a soft, porous limestone called *tufa*. These works included statues and carvings found in tombs and reliefs that decorated boxes containing the ashes of the dead. The Etruscans showed a fondness for gruesome figures, and for portraiture, especially portraits of ancestors. However, Etruscan artists gradually adopted classical Greek styles in sculpture.

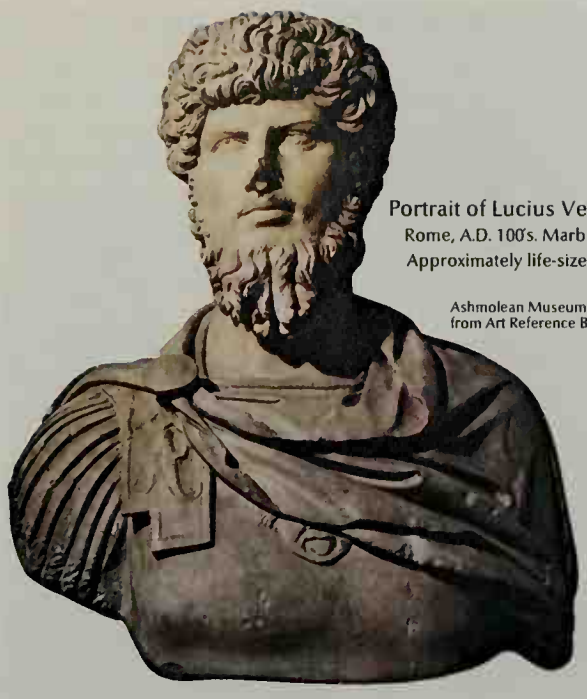
Roman sculpture. The earliest Roman sculpture was influenced by the Etruscans to the north of Rome and by Greek colonists to the south. After the Romans conquered Greece and the Hellenistic kingdoms during the 140's B.C., they brought hundreds of Greek statues to Italy. They also encouraged Greek artists to work for Roman patrons.

Greek artists brought to Italy the fully developed Hellenistic style, especially that of Alexandria. From 100 B.C. to A.D. 100, artists produced many works in a Greek style that at the same time expressed Roman ideas.

Portraiture was important in Roman sculpture. A typical portrait is the *Portrait of Lucius Verus* (page 248), a Roman emperor from A.D. 161 to 169. Such portraits were more realistic than the Greek examples because Greek sculptors still idealized facial features to some degree. Compare the idealized Greek head in the **Aristophanes** article with the realistic Roman portrait in the **Cicero, Marcus Tullius** article. Roman sculptors often combined a Roman portrait head with a copy of a Greek statue of a god. They copied and changed famous Greek statues freely. For examples of Roman portrait sculpture, see **Augustus; Caesar, Julius; Nero.**

Terme Museum, Rome, from Art Resource Bureau

Statue of a seated boxer
Greece, about 100-70 B.C. Bronze. About 4 ft. 2 in. (1.27 m) high.



Portrait of Lucius Verus
Rome, A.D. 100's. Marble.
Approximately life-sized.

Ashmolean Museum, Oxford, from Art Reference Bureau

The Romans were religious and created many richly carved altars. Most altar reliefs showed ceremonies or symbolic stories. A famous example is the Altar of Peace in Rome that celebrated the peace brought to the empire by Emperor Augustus.

The Romans were also particularly interested in showing historical events, a theme that the Greeks had avoided. Reliefs on commemorative arches and columns tell the story of military campaigns. The best-known columns are *Trajan's Column* (this page) and the column of Marcus Aurelius, both of which show the Romans battling foreign peoples.

Relief decoration on coffins was more Greek than Roman in style and subject matter. However, many reliefs symbolized Roman and, later, Christian ideas about death.

Representative Roman sculptures are shown in **Clothing** (The Romans); **Drama** (Roman drama); **Europe** (History); **Faun**; **Mythology** (Roman mythology); **Rome, Ancient**; **Slavery**; **Toga**.

Medieval sculpture

Medieval sculpture had no definite beginning date. It emerged from the tradition of ancient Greek and Roman sculpture that gradually had become fragmented and technically inferior after the A.D. 200's. Medieval sculpture developed into an artistic tradition in its own right about A.D. 800, largely due to the cultural patronage of the great ruler Charlemagne.

Charlemagne conquered most of the area that is now France, Germany, and Italy. To stabilize this vast empire, he encouraged education for the aristocracy and founded a permanent capital at Aachen, Germany. He established centers of learning in royal monasteries and in his imperial court. Those centers also produced art.

Early medieval sculpture. *Carolingian* art, named after Charlemagne's family, extended from the late 700's through the 800's. Workshops attached to monasteries produced most surviving sculpture of this time. As a result, artistic production was largely religious, and chiefly applied to objects used in Christian worship services. Carolingian artists created sculpture for covers of Bibles, as decoration for parts of church altars, and for crucifixes and giant candlesticks placed on altars. Lack-

Trajan's Column (detail)
Relief showing Trajan's campaign against the Dacians. Rome, A.D. 113.
Marble. Relief band about 4 ft. 2 in. (1.27 m) high.

Near Trajan's Forum, Rome; WORLD BOOK photo by Leonard von Matt

ing other models, sculptors imitated miniatures painted on religious manuscripts.

Most Carolingian sculptures were reliefs. Some told stories, while others promoted ideas. Storytelling scenes were done in a generally realistic style. The gold and silver *Altar frontal* (this page) was made about 835 for the Church of Sant' Ambrogio in Milan, Italy. The relief portrays an early event in the career of Saint Ambrose, his appointment as consul-general of Milan. The figures interact with each other in a believable manner within the shallow space of an abbreviated landscape.

A contrasting style of images is represented by the *Aachen situla* (this page), made about 1000. This jeweled ivory bucket was meant to hold holy water that was sprinkled by a bishop in solemn processions. The artist endowed the rows of rulers, saints, and guardians with a timeless sacred quality by presenting them unrealistically in a static frontal pose. At the same time, the precious materials of the bucket certified the spiritually cleansing value of the water.

The purpose of the Aachen situla typified the spread of liturgical items that developed with the elaboration of the worship service beginning in the late 800's. The expansion of the liturgy led to the creation of many objects, such as bishops' *crosiers* (staffs), vessels called *pyxes* to hold Communion wafers, and containers called *reliquaries* to hold the body parts of saints.

The 1000's. The use of relief to decorate small religious objects continued throughout the Middle Ages, but after 1000 sculptors also began to produce larger-scale church furnishings. For example, artists used cast bronze to make monumental doors, candelabra, baptismal fonts, and tomb slabs. By 1100, sculptors also began to make marble furnishings, recalling the grandeur of ancient Rome. The *Bari throne* (page 250) in Bari, Italy, may have been created for a meeting of Pope Urban II and church leaders in 1098. The throne extends the tradition of working in precious metals to stone carving, with figures sometimes cut virtually in the round. Other marble furnishings with relief images include pulpits, choir railings, shrines, and table altars.

The Treasury, Aachen Cathedral, Germany

Aachen situla

Holy water vessel from Aachen Cathedral, Germany, 1000. Ivory and jewels. 7 in. (18 cm) high.

SCALA/Art Resource

Altar frontal by Volvinus

Detail from a relief sculpture in the Church of Sant' Ambrogio, Milan, Italy, about 835. Gold and silver.

During the 1000's, architectural sculpture began a renewal. In the next 100 years, it became the principal area of medieval sculptural achievement. The *capital* (top of a column) from the church of St.-Benoît-sur-Loire (page 250) in France has been dated as early as the 1020's. It may be one of the earliest medieval examples of figurative stone sculpture conceived in high relief. The sculpture represents the flight into Egypt of Joseph, the Virgin Mary, and the infant Jesus. The carving is skillful, but the figures are crudely portrayed. The work was carved by a mason from an architectural workshop instead of a monk from a monastery studio. The work thus marked the appearance of sculpture as a new artistic profession for *artisans* (craftworkers) outside monasteries.

The peak of architectural sculpture. With the *Tympanum of the central portal of Vézelay Abbey* (page 228) in the 1120's, architectural sculpture was in its period of greatest creativity. The portal represents an intricate and subtle image of the feast of the Pentecost, when the apostles reported that the Holy Spirit had entered into them. The agitated figures of Jesus and the apostles are draped in swirls of garment folds to convey an otherworldly spirituality through their powerful expressive-

Malcolm Thurlby

Flight into Egypt
Capital from a column in the Church of St.-Benoît-sur-Loire, France, 1000's. Stone.

ness. The portal marks the extension of sculptured decoration to the public area of churches. With such works, sculptors established that images could be employed to proclaim complex theological concepts.

The *Visitation group* (page 250) on the west-central portal of the Cathedral of Notre Dame in Reims, France, was carved 100 years after the Vézelay portal. The sculptor portrayed the Virgin Mary and Saint Elizabeth. This work represents a completely different approach to sculptured imagery from the Vézelay portal. The figures are larger than life-sized and lifelike in appearance. The sculptor created them with believable proportions and anatomy, and used different textures for the hair, skin, and fabric. As a result, the viewer could regard the scene as a living vision, knowing all along that the figures are made of stone.

The different styles of the two portals represent a fundamental change in the nature and function of images. The frank artificiality of Vézelay contrasts with the lifelike illusion of Reims. But both conceptions were prompted by the conviction that images could promote spirituality by vividly representing sacred truths.

Later medieval sculpture. Patrons and sculptors of the 1300's and 1400's turned sharply away from the preoccupations of their predecessors. In the 1100's and 1200's, sculptured portals had displayed in public a visual interpretation of religious truths. Late medieval sculpture primarily reflected or stimulated the religious devotion of the individual.

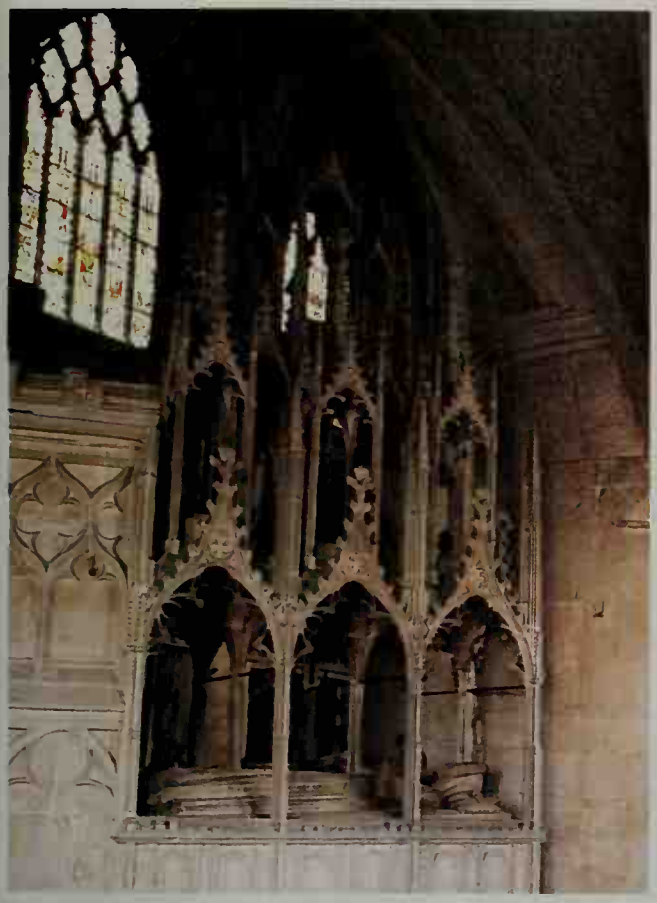
Monumental tombs became a major sculptural form. These tombs featured a life-sized *effigy* (image) of the deceased intended to praise his or her virtue. Tombs were as much miniature architecture as sculpture. A typical tomb was covered by a richly decorated canopy or set into a splendidly framed wall niche. The *Tomb of*

SCALA/Art Resource

Bari throne
Church of St. Nicholas, Bari, Italy, 1098. Marble.

Hirmer Fotoarchiv

Visitation group
Figures from Cathedral of Notre Dame, Reims, France, 1220's. Stone.



R. K. Morris, University of Warwick, Coventry, England

Tomb of Hugh le Despenser
Tewkesbury Abbey, England, about 1340. Stone.

Olomouci Museum, Olomouc, Czech Republic

Sternberk Madonna
Painted stone. 33 in. (84 cm) high. About 1400.

Hugh le Despenser (this page), Earl of Gloucester, was created about 1340 for Tewkesbury Abbey in England. The figure on the tomb shows the dead nobleman as a Christian knight, lying with his hands folded in prayer. Originally, statues of saints were also set into little niches, testifying to the earl's holiness.

The chief artistic concern in late medieval sculpture was the free-standing devotional statue. These statues were not displayed on main altars but stood to the side or at the entrance of a lesser chapel. There the statue served as the focus for private prayers and the burning of devotional candles. For more than 200 years, no theme could rival that of the Virgin Mary in popularity. She was usually represented standing and holding the infant Jesus. Worshipers asked Mary to forward their prayers to heaven and to plead with God for special help.

Artists variously imagined Mary as a simple maiden, a noble lady, or the Queen of Heaven. The *Sternberk Madonna* (this page), carved about 1400 in Bohemia (now part of the Czech Republic), typifies the elegant, idealized feminine quality of later medieval statues of Mary. These statues, sometimes called *beautiful Madonna statues,* related unblemished beauty to exalted virtue. The statues were intended to reassure the worshiper of the Virgin's unfailing willingness to help those who called on her. For another example, see **Stoss, Veit.**

See **Carolingian art; Gothic art; Romanesque architecture; Cathedral; Milan Cathedral; Notre Dame, Cathedral of; Architecture** (Gothic architecture).

Italian Renaissance sculpture

Figures made by medieval sculptors of northern Europe represented types rather than individuals, such as the concept of a "good man." But Italian Renaissance sculptors portrayed individual persons—for example, a particular man or woman who was good.

Renaissance sculpture reflected the new outlook on life that first appeared in Italy during the early 1300's. This outlook, which later scholars termed *humanism,* emphasized the importance of human beings and their activities. Humanism had its roots in the civilizations of ancient Greece and Rome. The Renaissance was given its name, which means *rebirth,* because of the revival of interest in classical art, architecture, and civilization. Artists and scholars, especially in Italy, wanted to recapture the spirit of the Greek and Roman cultures in their own art, literature, and philosophy. For more information about this rebirth of interest in classical culture, see **Humanism; Renaissance.**

In the late 1200's, Nicola Pisano and his son Giovanni began the revolutionary changes that led up to the Renaissance in Italian sculpture. They were architects and designers as well as sculptors, and are noted for their reliefs and ornamentation on pulpits. *The Massacre of the Innocents* (page 252) by Giovanni Pisano is an example. The dense composition of this relief shows that the sculptor was inspired by the carved Roman coffins called sarcophagi. Its content, in which each person reacts as an individual, shows the new attitude of the Ren-

aissance. The actual carving remains in the medieval Gothic style, however. For an earlier work by Nicola Pisano, the pulpit for the Baptistery of Pisa, see the **Relief** article.

During the 1300's, political and economic troubles in Italy limited sculptural activity. But the great revival of art in Florence about 1400 brought two generations of sculptors who were the equals of any artists anywhere at any time. They returned to classical Mediterranean traditions and turned away from the Gothic style, which was more at home in northern Europe.

Early Renaissance. The greatest sculptor of the early Renaissance was Donatello. By 1409, he had produced a stone statue of *David* (this page) which, though Biblical in subject matter, was entirely new in spirit—the portrait of a proud, triumphant boy. In another statue of David, a bronze completed about 1430, Donatello revived the use of the nude figure. This statue reestablished the classical idea of beauty—the naked human body. The statue is shown in the **Renaissance** article. For other examples of sculpture by Donatello, see **Donatello** and **Dragon.**

WORLD BOOK photo by Leonard von Matt

The Massacre of the Innocents by Giovanni Pisano
Detail from a panel of the pulpit in the Church of Sant' Andrea. Pistoia, Italy, 1298-1301. Marble. 33 in. (84 cm) high.

Museo Nazionale del Bargello, Florence, SCALA/Art Resource

David by Donatello
Italy, about 1408. Marble. Figure about 5 ft. 2 in. (1.57 m) high.

The new naturalness quickly affected sculpture throughout Italy. Donatello decorated the pulpits and singing galleries of churches in Florence and Padua with merry *putti* (singing and dancing children). Luca della Robbia made popular colored terra-cotta figures that were copied for generations. Sculptors also began to make figures of the Virgin Mary whose models might have been local women. These sculptures differed greatly from the formal, impersonal Romanesque and Gothic types. For an example of della Robbia's work, see **Della Robbia, Luca.**

Other new forms of sculpture developed during the 1400's, including lifelike portrait busts and great monuments in the classical style. Desiderio da Settignano became famous for portraits. Among the other brilliant sculptors of the 1400's were Jacopo della Quercia, Michelozzo Michelozzi, Bernardo and Antonio Rossellino, and Agostino di Duccio.

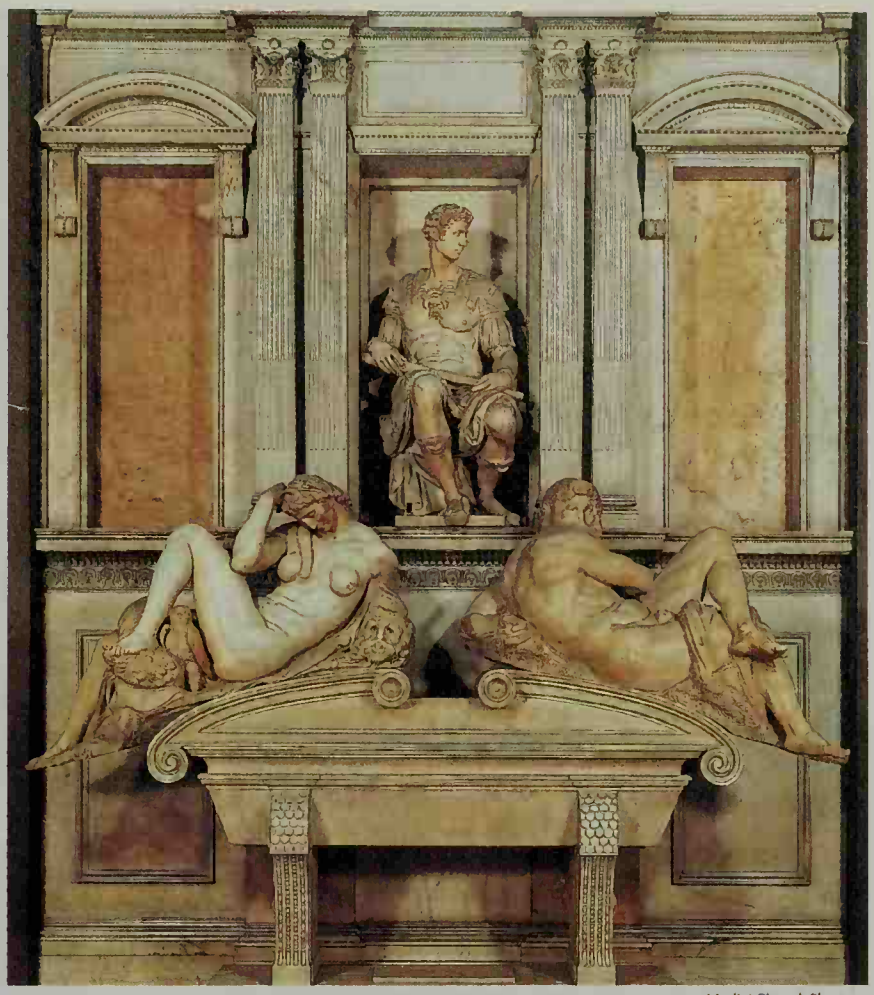
In the mid-1400's, Donatello moved to Padua. His style of modeling became more precise and sharp, and influenced the whole trend of sculpture in northern Italy. Among the sculptors influenced by this new style were the Mantegazza brothers, Giovanni Amadeo, the Lombardi family, and the great bronze worker Andrea Briosco, who was called *Il Riccio.* They all showed rather stylized, flattened planes in their works. Only in later nonreligious works, such as small bronzes and medals, did sculptors return to rounder, classical forms.

Two important sculptors of the late 1400's were Antonio del Pollaiuolo and Andrea del Verrocchio, both of Florence. Pollaiuolo, like Donatello and many other artists of this period, made a careful study of the appearance of muscles while the body is in motion. These artists caught fleeting moments of tense action in their poses. Verrocchio designed the powerful realistic portrait of the Renaissance political and cultural leader Lorenzo de' Medici. This portrait is shown in the **Renaissance** article.

Michelangelo. The great flood of Italian genius crested in the early 1500's in Michelangelo Buonarroti. His great brooding sculptures, including the figures

Piazza della Signoria, Florence
(SCALA/Art Resource)

Statue of Perseus by Benvenuto Cellini
Italy, 1545-1554. Bronze. Figure 10½ ft. (3.20 m) high.



Medici Chapel, Florence
(SCALA/Art Resource)

Tomb of Giuliano de' Medici by Michelangelo
Italy, about 1524-1534. Marble. Figures life-sized.

of *Night* and *Day* on the *Tomb of Giuliano de' Medici* (this page) in Florence, carry the observer beyond earthly reality. The deep feeling and emotion of his figures set them apart from all other sculpture of that time. For additional examples of Michelangelo's sculpture, see **Italy** (Arts) and **Michelangelo.**

Most other sculptors of the 1500's produced rather forced adaptations of imperial Roman figures and groups. Some monumental dignity can be seen in the works of such Venetian sculptors as Jacopo Sansovino and Alessandro Vittoria. Other sculptors followed Giambologna's experiments in composition in which figures turn and twist in complicated poses. Still others, including Benvenuto Cellini and Bartolommeo Ammannati, developed the *mannerist* style (see **Mannerism**). This style emphasized grace and elegance, and resulted in the creation of slender, artificial figures. An example is Cellini's bronze *Statue of Perseus* (this page). Cellini's famous saltcellar for King Francis I of France is shown in the article **Cellini, Benvenuto.** For more information on Italian Renaissance sculpture, see **Florence** (pictures); **Ghiberti, Lorenzo; Pisano, Giovanni; Pisano, Nicola.**

Sculpture from 1600 to 1900

European sculpture. The greatest master of European sculpture in the 1600's was Gian Lorenzo Bernini of Italy. Bernini was a superlative craftsman and also an outstanding architect. His sculpture for the *Tomb of Pope Alexander VII* (page 254) shows the wide range of his talent. The work is typical of the *baroque* style of the period because it was designed to appeal primarily to the emotions and senses. Bernini combined emotional and sensual freedom with theatrical presentation and an almost photographic naturalism. Bernini's saints and other figures seem to sit, stand, and move as living people—and the viewer becomes part of the scene. This involvement of the spectator is a basic characteristic of baroque sculpture.

The sculptors who succeeded Bernini in Rome during the late 1600's softened the dynamic and showy baroque style. They used a more static and restrained classical style. These artists were technically skilled and made hundreds of monuments that filled the churches of the time. By the early 1700's, they had become more interested in technical skill than in content, and their art reflected the change. But these artists had an important influence on sculptors of France and Flanders who made up the Franco-Flemish school.

Franco-Flemish sculptors were responsible for many church and public monuments built in northern Europe during the 1700's. Their sculptures decorated many royal palaces and gardens, including Versailles in France. These artists all followed the same style. They combined naturalistic details with artificial poses and

gestures, as shown in Antoine Coysevox's statue of *Mercury* (this page).

A brilliant new movement called *rococo* grew up in Germany during the early 1700's. The movement was led by such artists as Ignaz Gunther and Ferdinand Dietz, whose works are dramatic, colorful, and technically superb. Rococo saints and goddesses mingle in architecture with plasterwork and painted ceilings to create an extraordinary world of fantasy.

The *neoclassical* movement arose in the late 1700's. The members of this vast international school restored what they regarded as classical principles of art. They were direct imitators of ancient Greek sculptors. They emphasized classical drapery and the nude. Leading neoclassical sculptors included Antonio Canova of Italy, John Flaxman of England, and Bertel Thorvaldsen of Denmark. Thorvaldsen's delightful marble statue *A Shepherd Boy* (this page) is typical of the neoclassical style. This style greatly influenced churchyard and public monuments.

Jean Antoine Houdon of France was perhaps the greatest European sculptor of the 1700's. He was known chiefly for his portraits of important men and women in Europe and America. These portraits show Houdon's ability to capture the personalities of his subjects and his genius at working in a wide variety of materials. The marble statue of the French philosopher *Voltaire* (page 255) is one of his best-known works.

The *romantic* movement began in the 1830's and existed side by side with neoclassicism until about 1900. Romantic sculpture was sentimental, and it appealed to

St. Peter's Basilica, Rome; SCALA/Art Resource

Tomb of Pope Alexander VII by Gian Lorenzo Bernini
Italy, 1671-1678. Marble and gilt bronze. Figures larger than life-sized.

Thorvaldsens Museum, Copenhagen, from Art Reference Bureau

A Shepherd Boy by Bertel Thorvaldsen
Denmark, 1817-1825. Marble. 4 ft. 9 in. (1.45 m) high.

Gardens of the Tuileries, Paris; WORLD BOOK photo by Leonard von Matt

Mercury by Antoine Coysevox
France, 1700-1702. Marble. About 10 ft. (3.05 m) high.

the senses. Leading sculptors who worked in the romantic style included François Rude, Jean Baptiste Carpeaux, and Auguste Rodin, all of France. Such works as Rodin's *Orpheus* (this page) emphasize the possibilities of the modeler's technique. Rodin's technique greatly influenced sculpture of the 1900's. For additional examples of European sculpture of this period, see **Adonis; Canova, Antonio; France** (Arts); **Rodin, Auguste.**

American sculpture. North America had no professional sculptors until the late 1700's. However, anonymous craftworkers created fine examples of what is called *folk art.* The *Gravestone* by Zerubbabel Collins shown on this page and other gravestones in New England cemeteries reflect Puritan ideals in crude but vigorous reliefs. Many metal weather vanes featured fanciful designs.

In the 1820's, American sculptors started to go to Italy, where they were greatly influenced by the classical works they saw. Congress commissioned Horatio Greenough to make a colossal marble *Statue of George Washington* (page 256). Greenough represented his subject seated, seminude, in the pose of the Greek god Zeus. Hiram Powers created smooth and impersonal nude mythological figures, and some remarkable realistic portrait busts of public men. William Rimmer made a

Musée Lambinet, Versailles, France; photo by Giraudon/Art Resource

Voltaire by Jean Antoine Houdon
1781. Marble. Life-sized.

Orpheus by Auguste Rodin
France, 1892. Bronze.
4 ft. 11 in. (1.50 m) high.

Musée Rodin, Paris, from Art Reference Bureau

WORLD BOOK photo by Robert Crandall

Gravestone by Zerubbabel Collins
United States (Columbia, Conn.), 1791. Marble. 31 ½ in. (80 cm) high.

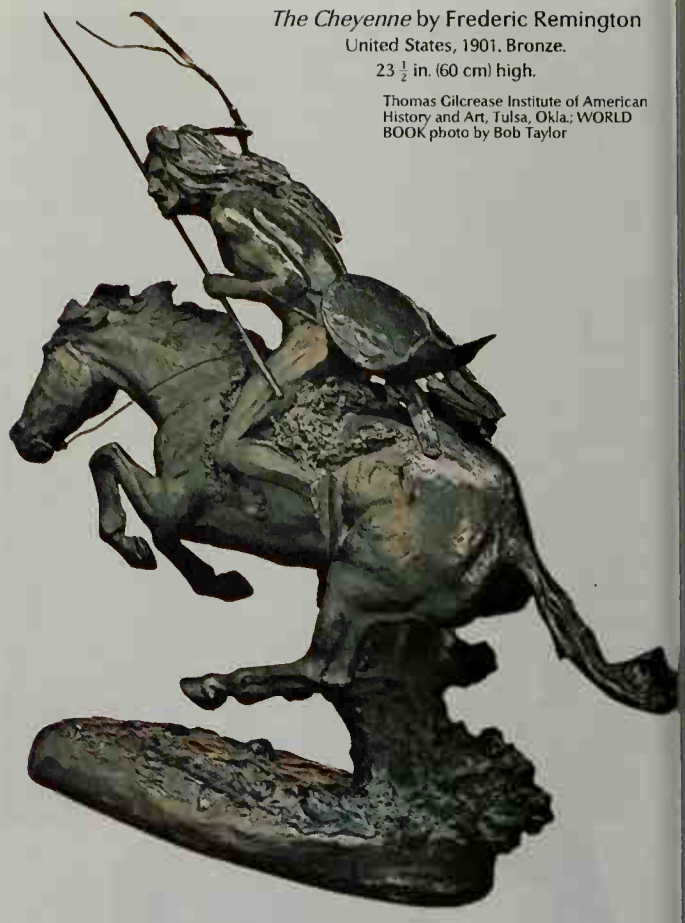
few dramatic, struggling figures. These figures were more emotional, powerful, and tragic than earlier American works. They showed a great knowledge of anatomy and a strong feeling of tension. John Rogers made small groups of American Civil War scenes. Rogers also created works that suggested the pleasant, warm-hearted quality of small-town everyday life.

About the mid-1800's, French influence began to be felt more strongly than Italian. The greatest American sculptor of his period was Augustus Saint-Gaudens, best known for his statues of Abraham Lincoln.

Important sculptors of the late 1800's included Daniel Chester French, who made many serene and idealistic compositions, and George Grey Barnard, master of the expressive human figure. Frederick MacMonnies introduced extravagant and rich surface details into the monumental style. Frederic Remington showed another aspect of American life in his small bronzes. He used vivid, dramatic themes from the life of the Far West in such works as *The Cheyenne* (this page). For additional examples of American sculpture of this period, see **Folk art; Remington, Frederic; Saint-Gaudens, Augustus.**

Modern international sculpture

Sculpture of the 1900's became increasingly international in character as national differences in the art form have disappeared. New ways of thinking about sculpture resulted in exciting and original developments. The



The Cheyenne by Frederic Remington
United States, 1901. Bronze.
23 ½ in. (60 cm) high.
Thomas Gilcrease Institute of American History and Art, Tulsa, Okla.; WORLD BOOK photo by Bob Taylor

The Smithsonian Institution, Washington, D.C.; WORLD BOOK photo by Robert Crandall

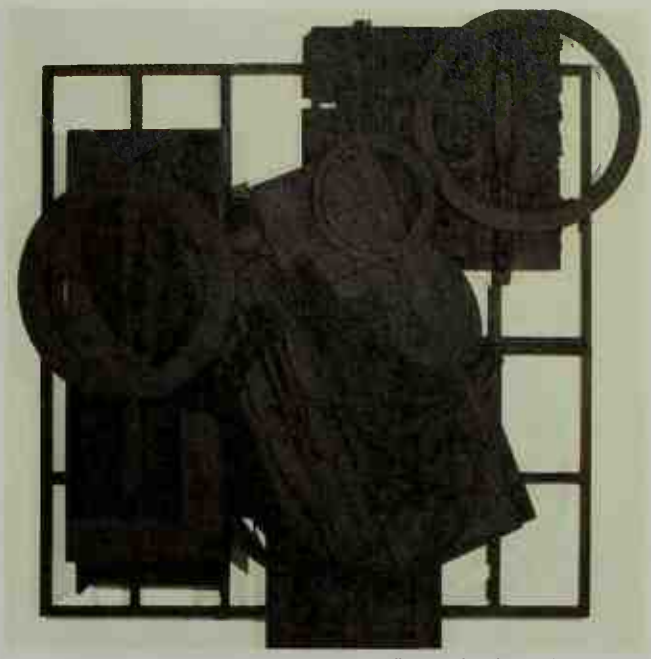
Statue of George Washington by Horatio Greenough
United States, 1840. Marble. 11 ⅓ ft. (3.45 m) high.

The Museum of Modern Art, New York City, gift of the artist

Guitar by Pablo Picasso
France, 1912-1913. Construction of sheet metal and wire. 30 ½ in. (77.5 cm) high.

Bicycle Wheel
by Marcel Duchamp
1951, third version after lost original of 1913. Metal wheel 25 $\frac{1}{2}$ in. (64.8 cm) in diameter mounted on a painted wood stool.

The Museum of Modern Art, New York City, the Sidney and Harriet Janis Collection



Private collection; photo by ESM/Art Resource

Mirror Shadow VIII by Louise Nevelson
1985. Wood. 9 ft. 1 $\frac{1}{2}$ in. (2.8 m) high.

human figure, for many years the favorite subject of sculptors, became less important. Many sculptors became more involved in problems of pure form, avoiding recognizable content. Artists also often used the shapes of modern machines in their works. New materials, such as plastics and aluminum, made a strong impact on the look of sculpture in the 1900's.

Cubism and Futurism. Many new artistic ideas appeared during the years just before World War I began in 1914. Cubism and Futurism were two related movements that led to experiments in both sculpture and painting. Cubist sculptors, including the Spanish-born Pablo Picasso and the Lithuanian-born Jacques Lipchitz, represented objects in such basic geometrical forms as cubes, cylinders, and cones. They were also among the first to experiment with hanging sculptures on walls in the manner of paintings. An example is Picasso's sheet metal and wire *Guitar* (page 256).

Futurist sculptors tried to show how space, movement, and time affected form. These artists portrayed objects in motion, rather than their appearance at any particular moment. An example is Umberto Boccioni's *Unique Forms of Continuity in Space* (page 231).

Constantin Brancusi gave intense life and character to severely controlled and limited forms. Brancusi's famous *Bird in Space* (this page) abstractly suggests soaring movement without attempting to physically portray a bird. See **Brancusi, Constantin.**

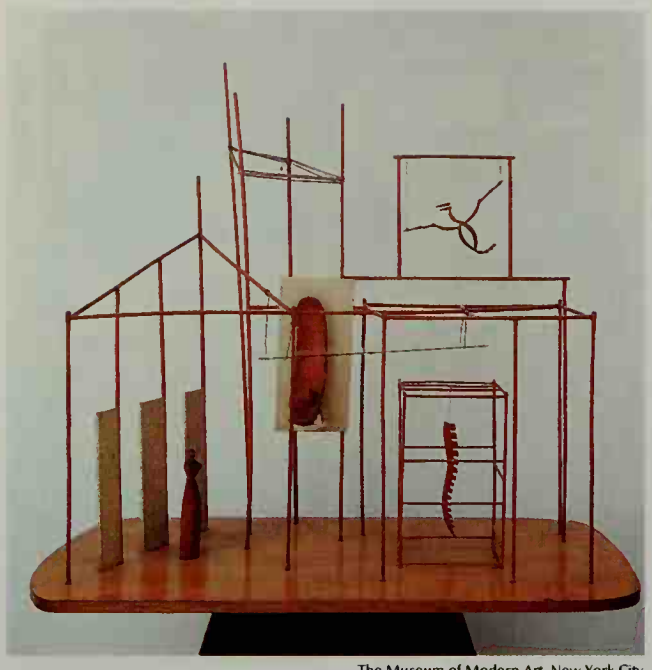
Assemblages. During the early 1900's, two revolutionary art movements called Dadaism and Surrealism made significant new contributions to sculpture. Dada artists, such as Marcel Duchamp of France, explored the use of discarded materials not previously accepted by artists. Dadaists created works out of abandoned machine parts, pieces of wood, household items, and similar articles, called *found objects*. These artists often pieced elements together to create a type of sculpture now called *assemblages* or *constructions*. An early ex-

Bird in Space
by Constantin Brancusi
1940. Polished bronze.
4 ft. 4 in. (1.32 m) high.

Collection of Peggy Guggenheim, Venice; WORLD BOOK photo by Erich Lessing, Magnum

Albright-Knox Art Gallery, Buffalo, New York

Reclining Figure by Henry Moore
1936. Elmwood. 35 in. (89 cm) long.



The Museum of Modern Art, New York City

The Palace at 4 A.M. by Alberto Giacometti
1932-1933. Wood, glass, wire, and string. 28 $\frac{1}{4}$ in. (71.8 cm) high.

ample is Duchamp's *Bicycle Wheel* (page 257). Some sculptors, such as Alberto Giacometti of Switzerland, captured the favorite surrealist subject matter of dreams, nightmares, or fantasies. Giacometti's *The Palace at 4 A.M.* (this page) is an example. See **Dadaism.**

A later example of assemblage is *Mirror Shadow VIII* by the American sculptor Louise Nevelson (page 257). In this work, Nevelson assembled machine-made wooden objects that become large and extraordinary environments almost resembling buildings. Many of her wooden constructions seem to suggest dreams of eternity. See **Nevelson, Louise.**

Henry Moore. Not all sculptors of the early and middle 1900's abandoned figurative sculpture. Certain artists developed new and original ways of handling figurative forms. Henry Moore of England made vast wood or stone figures such as *Reclining Figure* (page 257). Although the human figure is clearly recognizable, it has been reduced to an abstract form that also seems part of a landscape. The *voids* (holes) in the statue allow it to interact more fully with the space around it and add a sense of mystery to the work.

Varieties of abstraction. The American sculptor David Smith played a major role in exploring the sculptural possibilities of stainless steel. Using abstract geometric forms, he created monumental works that dramatically experimented with balance, space, and surface treatment. Many of his welded works seem to defy gravity, such as *Cubi XIX* (page 259). Even more abstract are the simplified representations of organic forms by the French artist Jean Arp.

During the mid-1900's, nonfigurative sculpture dominated the work of many artists. Some young sculptors created works that seem to have been produced by machines. These artists made sculptures in aluminum, plastics, and other industrial materials. The forms remain severely geometrical, deliberately anonymous, and almost totally impersonal. These artists became known as *minimalists.*

The American sculptor Tony Smith created works that typify the minimalist style. In *Cigarette* (this page), Smith produced a sculpture that is clear, simple, and based on elementary geometric forms and relationships. Smith deliberately avoided self-expression. *Cigarette* suggests no recognizable ideas or images. Its impact lies in the materials used and the proportional relationships of the parts. In many ways, Smith worked like an engineer rather than a traditional sculptor. Other leading minimalist sculptors include the Americans Carl Andre and Donald Judd.

Cigarette by Tony Smith
1967. Steel. 15 ft. (4.6 m) high.

Albright-Knox Art Gallery, Buffalo, N.Y.,
Gift of the Seymour H. Knox Foundation, Inc.

Woman with Suitcases
by Duane Hanson
1973. Painted fiberglass and polyester. Life-sized figure.

Collection of Mr. and Mrs. Morton Neumann
(O. K. Harris Works of Art)

© Gianfranco Gorgoni, Sygma

Surrounded Islands
by Christo
Islands off the coast of Florida. 1983.
Pink polypropylene fabric.

Since the mid-1900's. During the 1960's and 1970's, some artists began practicing an extreme form of realism, commonly called Superrealism. The Superrealists included the Americans John De Andrea and Duane Hanson. These artists created life-sized figures in realistic poses or in everyday situations. Many of Hanson's works comment on society, while De Andrea's tend to explore the relationship between the ideal and reality.

Duane Hanson's *Woman with Suitcases* (page 258) combines the technique of casting from a living subject with fiberglass and polyester materials. The result seems alive. To make the illusion of reality more complete, Hanson added real hair, clothes, and accessories to the sculpted figure.

Some sculptors have concentrated on designing and creating works of art sculpted out of the landscape,

Collection of Mrs. Robert B. Mayer (WORLD BOOK photo);
© Marisol Escobar/Licensed by VAGA, New York, New York

The Family by Marisol
1963. Painted wood and other materials. 6 ft. 7 in. (2 m) high.

The Tate Gallery, London,
from Art Reference Bureau

Cubi XIX by David Smith
1964. Stainless steel. 9 ft. 5 in. (2.87 m) high.

Collection of the artist; photo from Sandak Inc.

Dragon by Judy Pfaff
1981. Mixed media.

using rocks, earth, water, and other natural materials. These works are called *environmental sculptures,* and sometimes *land art* or *earthworks.* The Bulgarian artist Christo created *Surrounded Islands* (page 259), a short-term project of surrounding a group of islands in Florida with bright pink polypropylene fabric.

The late 1900's saw the distinction between sculpture and other art forms become less definite. Today, sculptors create works from shaped and painted canvas, solid colored forms, and combinations of many materials.

The American sculptor Marisol wittily combined painting and wooden sculpture with actual clothing, furniture, and other everyday objects. Many of her sculptures consist of groupings of several life-sized figures. An early example of Marisol's style is *The Family* (page 259).

Robert Arneson of the United States and other artists who work in ceramics have broken down the artificial division between ceramics and sculpture. Judy Chicago's *The Dinner Party* (page 229) integrates traditional women's crafts such as weaving and embroidery with ceramics on a large triangular table. Through *The Dinner Party,* the artist pays tribute to a number of key women in history and to the feminist movement.

Artists such as the American Judy Pfaff are involved in *site-specific installations.* Such works are created for a definite site and may temporarily transform an art gallery or museum space into a brightly colored, emotionally stimulating environment. The viewer can walk through this environment, almost as if stepping into an abstract painting. Pfaff's site-specific installations include painted ceilings, neon, plastic wall coverings, and barbed wire. Her playful *Dragon* (this page) was installed for an exhibition at the Whitney Museum of American Art in New York City.

M. F. Hearn, Joseph F. Lamb, Louise Lincoln, Elizabeth deS. Swinton, and Roger Ward

Related articles in *World Book.* See the *Arts* section of the various country articles, such as Japan (The arts). See also:

American sculptors

Baskin, Leonard
Borglum, Gutzon
Calder, Alexander
Dallin, Cyrus E.
Fraser, James E.
French, Daniel C.
Greenough, Horatio
Johns, Jasper
Lippold, Richard
Marisol
Milles, Carl
Nevelson, Louise
Noguchi, Isamu
Oldenburg, Claes
Powers, Hiram
Rauschenberg, Robert
Remington, Frederic
Rosenquist, James A.
Roszak, Theodore
Russell, Charles M.
Saint-Gaudens, Augustus
Segal, George
Smith, David
Taft, Lorado

French sculptors

Arp, Jean
Bartholdi, Frédéric A.
Barye, Antoine L.
Brancusi, Constantin
Coysevox, Antoine
Degas, Edgar
Houdon, Jean A.
Maillol, Aristide
Pevsner, Antoine
Rodin, Auguste

German sculptors

Barlach, Ernst H.
Lehmbruck, Wilhelm
Riemenschneider, Tilman
Stoss, Veit

Italian sculptors

Bernini, Gian Lorenzo
Boccioni, Umberto
Canova, Antonio
Cellini, Benvenuto
Della Robbia, Luca
Donatello
Ghiberti, Lorenzo
Michelangelo
Pisano, Giovanni
Pisano, Nicola
Pollaiuolo, Antonio del
Verrocchio, Andrea del

Other sculptors

Archipenko, Alexander
Christo
Epstein, Sir Jacob
Gabo, Naum
Giacometti, Alberto
Hepworth, Barbara
Lipchitz, Jacques
Lysippus
Meštrovi, Ivan
Moore, Henry
Phidias
Picasso, Pablo
Praxiteles
Thorvaldsen, Bertel

Famous sculptures

Elgin Marbles
Farnese Bull
Laocoön
Mount Rushmore National Memorial
Nefertiti
Sphinx
Statuary Hall
Statue of Liberty
Stone Mountain
Venus de Milo
Winged Victory

History of sculpture

Assyria (Art and architecture; picture)
Aztec (Arts and crafts)
Babylonia (Art)
Egypt, Ancient (Painting and sculpture)
Greece, Ancient (The arts)
Indian, American (Arts and crafts)
Maya (Arts and crafts; pictures)
Persia, Ancient (pictures)
Rome, Ancient (Arts and sciences)

Kinds of sculpture

Collage	Intaglio	Mobile	Sarcophagus
Gargoyle	Mask	Relief	

Methods and materials

Alabaster	Ebony	Jade	Plastics
Bronze	Fiberglass	Lacquer	Soapstone
Cast and casting	Iron and steel	Marble	Terra cotta
Clay	Ivory	Plaster of Paris	Welding
			Woodcarving

Styles

Baroque	Cubism	Humanism	Pop art
Byzantine art	Folk art	Impression-ism	Renaissance
Carolingian art	Futurism	Minimal art	Rococo
Classicism	Gothic art		Romanticism

Other related articles

Africa (The arts)
Art and the arts
Asia (Way of life)
Design
Inuit (picture)
Latin America (The arts)

Outline

I. The importance of sculpture
II. Sculpture as an art form
III. The sculptor at work
IV. Beginnings
V. Asian sculpture
VI. African sculpture
VII. Pacific Islands sculpture
VIII. Indian sculpture of the Americas
IX. Greek sculpture
X. Etruscan and Roman sculpture
XI. Medieval sculpture
XII. Italian Renaissance sculpture
XIII. Sculpture from 1600 to 1900
XIV. Modern international sculpture

Questions

Why did prehistoric peoples create sculpture?
What is sculpture in the round?
What is relief sculpture?
How can sculptors create the illusion of movement in their works?
How did Greek and Roman portrait sculpture differ?
What is a *nkisi*? What is an *ere ibeji*?
How did Buddhism influence Asian sculpture?
What is *minimalist* sculpture?
Where was most Carolingian art created?
How did Donatello influence Renaissance sculpture?

Additional resources

Level I

Opie, Mary-Jane. *Sculpture.* Dorling Kindersley, 1994.
Solga, Kim. *Make Sculptures!* North Light, 1992.
Pekarik, Andrew. *Sculpture.* Hyperion, 1992. *Art of Sculpture.* Scholastic, 1995.

Level II

Cheney, Sheldon W. *Sculpture of the World.* Viking, 1968. A standard history.
Causey, Andrew. *Sculpture Since 1945.* Oxford, 1998.
Penny, Nicholas. *The Materials of Sculpture.* Yale, 1994.
World of Art. Thames & Hudson, 1963- . Multivolume work. A worldwide survey of all media, including sculpture.

Scurvy is a disease caused by lack of *ascorbic acid* (vitamin C) in the diet. Foods especially rich in this vitamin when eaten fresh include citrus fruits, tomatoes, lettuce, celery, onions, carrots, and potatoes. Including such foods in the diet will prevent or cure scurvy.

If a person does not get enough vitamin C, any wound he or she might have heals poorly. The person also bruises easily. The walls of the *capillaries* (small blood vessels) become so weak that slight pressure may cause them to break. The mouth and gums become sore. The gums bleed, and the teeth may become loose. Patients lose their appetite, their joints become sore, and they become restless. Anemia also may develop.

Scurvy has been known since ancient times. It was once a common disease among sailors. During long voyages, sailors rarely had fresh fruits and vegetables. They lived on salt beef and *hardtack* (dry biscuits) for weeks at a time. The Portuguese navigator Vasco da Gama once lost about 100 out of 170 men from scurvy. In 1753, James Lind, a Scottish physician, showed that eating oranges and lemons would cure scurvy, and that adding lemon juice to the diet would prevent the disease. In 1795, the British Navy followed his advice and began issuing daily rations of juice to its men.

Improved understanding of nutritional requirements has made scurvy rare. Today, scurvy is mainly a disease of babies and elderly people whose diets are inadequate. Scurvy in infants is called *Barlow's disease.* It usually occurs when breast feeding stops. Bottle-fed babies should drink orange juice or tomato juice after the first month. Quinton R. Rogers

See also Vitamin (Vitamin C).

Scylla, *SIHL uh,* in Greek mythology, was at first a beautiful nymph. The Roman poet Ovid told how the sea-god Glaucus fell in love with Scylla when Glaucus saw her walking on the shore by the Strait of Messina. Scylla would not love Glaucus, and so Glaucus went for help to the sorceress Circe. Circe asked him to love her instead of Scylla, but he would not. In a rage, Circe turned Scylla into a sea monster, part woman and part fish, with heads of dogs growing out of her waist.

Scylla then lived in a cave above the Strait of Messina opposite the whirlpool Charybdis. Scylla seized and ate sailors that came too close. When Odysseus (Ulysses in Latin) passed that way, she seized six of his men (see Odyssey; Ulysses). Sailors tried to steer a middle course *between Scylla and Charybdis.* This expression is sometimes used when a person speaks of having to take a course between two evils. Cynthia W. Shelmerdine

Scythe, *syth,* an implement with a curved cutting blade, was once used to harvest grain and hay. It had a long, bent wood shaft, called a *snath,* and one or two handles. Farmers in the American Colonies cut grain with a *cradle scythe.* This type of scythe had four or five long, wooden "fingers" mounted parallel to the blade. The fingers caught the fallen grain. R. Douglas Hurt

Scythians, *SIHTH ee uhnz,* were ancient nomads who lived mainly north of the Black Sea in present-day Ukraine and southwestern Russia. They originated in the plains of what is now southern Kazakhstan. But tribes from China pressured most of the Scythians to move west in the early 600's B.C. Scythian territory expanded through the years. By the 300's B.C., these people lived as far west as present-day Hungary and eastern Germany, as far south as Palestine, and as far east as India.

The Scythians were famed as warriors. They were especially known for their skill as horse riders, and their mounted archers gave them a strong advantage in battle. They also engaged in a great deal of trade, particularly with the ancient Greeks.

The Scythians first appear in history about 675 B.C. From that time and throughout the 600's, they menaced

the Assyrians, who controlled a vast empire stretching from Egypt to Iran. By about 615 B.C., the Scythians had conquered much of Syria and Palestine. About 513 B.C., the Scythians prevented the Persian Empire under Darius I from expanding beyond Thrace—a region in the Balkan Peninsula—into the rest of eastern and central Europe. In the late 200's B.C., the Scythians were defeated by a people called the Sarmatians and restricted to the area of the Crimea in eastern Europe. They died out in the A.D. 200's. John A. Brinkman

SDI. See Strategic Defense Initiative.

Sea. See Ocean.

Sea, Law of the. See Law of the Sea Convention.

Sea anemone, *uh NEHM uh nee,* is a sea animal that looks like a flower called the *anemone.* The shape of the animal's body and its bright color give the sea anemone a plantlike appearance. Its body may be blue, green, pink, red, or a combination of colors. The sea anemone can move slowly. However, it usually remains fixed to a rock or other surface. Sea anemones are *cnidarians,* the group of water animals that includes corals, hydras, and jellyfish. The animal's body diameter varies from about $\frac{1}{4}$ inch (6 millimeters) in some species to over 3 feet (90 centimeters) in the giant sea anemone of Australia.

Like some other cnidarians, sea anemones are *polyps.* One end of the cylinder-shaped body attaches to rocks, shells, or wharf pilings. The other points outward. This end has a mouth surrounded by *tentacles* (slender whiplike organs). Sea anemones capture food with their tentacles. Stinging cells in the tentacles throw out tiny poison threads that paralyze other small sea animals. The tentacles drag prey into the mouth. The mouth leads to a large cavity, where the food is digested. When a sea anemone is disturbed, it pulls in its tentacles and shortens its body. It then looks like a round lump on a rock.

The animal reproduces by forming eggs, by dividing in half, or by *budding.* When it buds, a young sea anemone grows out of the base of the parent's body. Eventually, it breaks off and grows by itself. L. Muscatine

Scientific classification. Sea anemones belong to the phylum Cnidaria. Sea anemones are in the class Anthozoa.

See also **Animal** (picture: Animals of the oceans).

Sea cow is a term sometimes applied to the dugong and manatee, which belong to an *order* (group) of sea mammals called *Sirenia.* But the term more correctly applies to an extinct animal called *Steller's sea cow.* The Steller's sea cow was discovered in 1741 near the Commander Islands in the Bering Sea. The total population then probably numbered between 1,000 to 2,000. Sailors killed the animals for food, and by 1768 they were extinct. The Steller's sea cow lived in shallow water near shore. It fed on seaweed. It was the largest sirenian and the only one adapted to cold water. It grew to 25 feet (7.6 meters) long and weighed up to 11 tons (10 metric tons). See also **Dugong; Manatee; Sirenia.** Daniel K. Odell

Scientific classification. The Steller's sea cow belongs to the order Sirenia. It is in the family Dugongidae. Its scientific name is *Hydrodamalis gigas.*

Sea cucumber is a type of sea animal with a long fleshy body that may look like a cucumber. It belongs to a group of spiny-skinned animals called *echinoderms* (see **Echinoderm**). Other echinoderms, including sea urchins and starfish, have sharp spines on the outside of their bodies. A sea cucumber's spines, however, are buried deep in its skin. About 500 species of sea cucumbers live throughout the oceans. Some tropical kinds grow 2 to 3 feet (60 to 90 centimeters) long. Most sea cucumbers that live in cooler regions are much smaller.

A sea cucumber's mouth is at one end of the body. It is surrounded by branching tentacles. The tentacles can lengthen and shorten, catch food, and pass food into the mouth. There are five double rows of tiny tubelike structures called *tube feet* on the body. The tube feet have suction disks on their ends that help the animal crawl or attach itself to objects. A sea cucumber breathes by pumping water in and out of an organ called a *respiratory tree.* The animal also can throw out internal body parts to distract attackers. New body parts are later regrown. In Asia, sea cucumbers are dried and sold as food called *trepang* (see **Trepang**). John C. Ferguson

Scientific classification. Sea cucumbers belong to the phylum Echinodermata. They make up the sea cucumber class, Holothuroidea.

See also **Deep sea** (picture: The deep sea).

Sea fan is a colorful coral with a flat, fanlike shape. It has a strong, flexible *core* (internal skeleton) that branches to form a lacy network. A sea fan actually consists of a colony of individual coral animals called *polyps.* Each polyp has a cylinder-shaped body, at the top end of which is a mouth surrounded by eight tentacles. The polyps grow from the soft tissues that cover the skeleton. Sea fans live in tropical and subtropical reefs around the world. They are often colored brilliant red, yellow, orange, or purple. Robert S. Prezant

Scientific classification. Sea fans belong to the order Gorgonacea of the phylum Cnidaria. A common Florida species is *Gorgonia flabellum.*

See also **Coral** (picture).

Sea gull, any gull found on or near the sea. See **Gull.**

Sea horse. See Seahorse.

Sea level is the level of the ocean's surface. It changes continuously with the tides, and it varies from one part of the world to another. *Mean sea level* is the average sea level calculated from measurements made over a long period of time. Geographers use mean sea level as the starting level for measuring the height or depth of the earth's surface. For example, Mount McKinley in Alaska rises 20,320 feet (6,194 meters) *above* sea level. Death Valley, in California, is 282 feet (86 meters) *below* sea level. David S. McArthur

Sea lily is a sea animal that looks like a flower. It belongs to a group of spiny-skinned animals called *echinoderms* (see **Echinoderm**). This group also includes starfish and sea urchins. Sea lilies were abundant in prehistoric times, but only a few kinds remain today.

A sea lily lives mostly in deep ocean waters. It attaches itself to the ocean bottom with its stalk. The main part of its body, called the *calyx,* is on top of the stalk. Its mouth faces upward from the center of the calyx. Featherlike arms extend from the calyx into the water current. The arms have small shoots that collect food and pass it in grooves to the mouth. Sea lilies eat tiny water creatures.

Closely related animals called *feather stars* resemble sea lilies in appearance. But feather stars break from their stalks when young and live free, often on tropical coral reefs. Feather stars can swim short distances by waving their arms up and down. John C. Ferguson

Scientific classification. Sea lilies and feather stars belong

to the phylum Echinodermata. They form the class Crinoidea.

See also Ocean (picture: Benthos).

Sea lion. See Seal.

Sea of ... See articles on seas listed under their key word, as in Japan, Sea of.

Sea otter is a furry animal that lives in the North Pacific Ocean. Herds of sea otters dwell near the shores of western North America and Siberia. They seldom leave the water.

The sea otter swims using its flipper-shaped hind feet as paddles. It eats and sleeps while floating on its back. Sea otters often sleep in masses of floating seaweed called *kelp*. The female carries her baby on her chest as she paddles about on her back. She has one baby, called a *pup*, at a time.

Most sea otters grow from 4 to 5 feet (1.2 to 1.5 meters) long and weigh from 60 to 85 pounds (27 to 39 kilograms). A large male, however, may weigh up to 100 pounds (45 kilograms). Sea otters have thick brown fur

R. H. Armstrong, Animals Animals

A sea otter swims mostly on its back, paddling with its flipper-shaped hind feet. Its front paws grasp and hold objects.

that traps air and keeps their skin dry. The fur also insulates them against the cold. Unlike seals and sea lions, sea otters do not have a layer of blubber under their skin. A sea otter dives as deep as 180 feet (55 meters) for food and can stay underwater as long as four minutes. It uses its front paws for grasping and holding, as do some otters that live in fresh water. For information about freshwater otters, see the article on Otter.

Sea otters may eat as much as a fifth of their body weight every day. They feed on abalones, clams, crabs, fish, mussels, octopuses, sea urchins, and squids. Sea otters pry open shellfish in various ways. They use their teeth or their paws, and may pound one clam or mussel against another. A sea otter also may balance a rock on its belly and hammer the shellfish against it.

For centuries, sea otters have been hunted for their valuable fur. From the mid-1700's through the 1800's, fur traders killed so many sea otters that the animal almost disappeared. In 1911, Canada, Japan, Russia, and the United States signed a treaty that prohibited the hunting of sea otters. As a result, the world's sea otter population increased steadily. In 1989, an accident involving the U.S. tanker *Exxon Valdez* spilled more than 10 million gallons (38 million liters) of oil into Prince William Sound off the coast of Alaska. Between 3,500 and 5,500 sea otters are believed to have died due to the oil spill.

Daniel K. Odell

Scientific classification. The sea otter belongs to the weasel family, Mustelidae. Its scientific name is *Enhydra lutris*.

Sea parrot. See Puffin.

Sea serpent is a large, probably imaginary marine creature. Since ancient times, the legends of most peoples have told of such creatures as sea serpents, dragons, and unicorns. Witnesses have reported seeing sea serpents, but none of the snakelike monsters has ever been caught or washed ashore.

A sea serpent is probably just a group of leaping porpoises or a floating mass of giant seaweed. Other marine animals, including large eels, oarfish, sharks, and giant sea squids, have also been mistaken for sea serpents. Some scientists believe sea serpents may be the descendants of a prehistoric animal. The Loch Ness monster is a famous sea serpent that supposedly has lived in a Scottish lake since the 500's. Alan Dundes

See also Loch Ness monster.

Sea squirt is a name for a group of sea animals which are also called *ascidians*. These animals have a habit of squirting out water through one of two body openings. Adult sea squirts have leathery bottle-shaped bodies. All their adult lives they remain attached to stones, shells, and other fixed objects. Some sea squirts live in colonies. The adult gets its food from water that it draws into the digestive tract through one of the body openings, called the *incurrent siphon*. It squirts out the water from the other opening, the *excurrent siphon*.

Sea squirts go through a larval stage before they become mature. The larva looks like a tadpole and can swim about. It has a *notochord* (elastic rod) that extends through the tail. Because of this "backbone," scientists think sea squirts are relatives of the simplest fishlike animals, *lancelets* and *lampreys*. In a few days, the larva loses its tadpole shape. Soon it develops its adult form.

P. A. McLaughlin

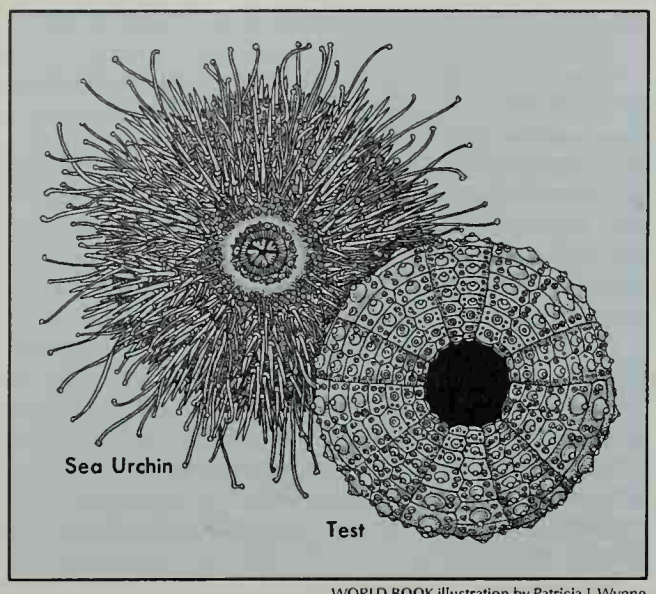
Scientific classification. The sea squirt is a member of the subphylum Urochordata. It makes up the class Ascidiacea.

Sea star. See Starfish.

Sea turtle. See Turtle (Sea turtles).

Sea urchin is a sea animal related to the starfish and the sand dollar. Sea urchins have ball-shaped bodies covered with long, movable spines. Close-fitting skeletal plates lie under the animal's skin and form a shell called a *test*. The spines are attached to the test. Some sea urchins found on coral reefs have especially sharp spines that are dangerous to divers. Sea urchins may be black, brown, green, purple, red, or white. They measure from 2 to 5 inches (5 to 12 centimeters) in diameter. They live in oceans all over the world. Sea urchins eat mostly plants found on rocks and on the sea bottom. A sea urchin's mouth is on the underside of its body. The animal scrapes up its food with a set of five movable teeth. Some sea urchins can dig holes into rocks with their teeth.

A sea urchin moves by pushing with its spines or by using its tentaclelike *tube feet*, which have suction disks at the ends. In addition, the animal's tube feet may function in respiration and as sense organs. Some sea urchins use their tube feet to cover themselves with old shells and seaweed in order to hide from starfish and other predators. The reproductive organs of sea urchins



WORLD BOOK illustration by Patricia J. Wynne

A sea urchin is covered by long, movable spines. The spines grow from a shell called a *test,* which lies just under the skin. The test protects the animal's soft body.

are edible and are considered a delicacy in Japan.

John C. Ferguson

Scientific classification. Sea urchins belong to the class Echinoidea in the phylum Echinodermata.

See also **Sand dollar; Starfish.**

Sea walnut. See **Ctenophore.**

Seabees are members of construction battalions of the United States Navy. The name is taken from the initials of the official name, Construction Battalion. Seabees build and repair overseas bases to support Navy and Marine Corps forces. They are also trained to defend what they build. They have built bases from the tropics to the polar regions, and their work includes projects such as airfields and waterfront facilities.

The first battalion of Seabees was authorized on Jan. 5, 1942. During World War II (1939-1945), most Seabees were experienced carpenters, plumbers, electricians, and engineers. They earned a reputation for effectiveness on such islands as Guadalcanal, Tarawa, and Guam. In 1947, the Seabees were made a permanent part of the U.S. Navy. The Seabees are administered by the Naval Facilities Engineering Command.

Critically reviewed by the United States Navy

Seaborg, Glenn Theodore (1912-1999), an American chemist, became known for contributing to the discovery of several elements heavier than uranium. Seaborg and his associate, Edwin M. McMillan, shared the 1951 Nobel Prize for chemistry for the discovery of the elements plutonium (Pu), americium (Am), curium (Cm), berkelium (Bk), and californium (Cf). Seaborg later contributed to the discovery of einsteinium (Es) and mendelevium (Md). All of these elements are radioactive, and all are artificially created.

Seaborg made the first of his discoveries in 1940. That year, he and his associates at the University of California at Berkeley created plutonium by bombarding a sample of uranium with nuclear particles. This process produced a change in the nucleus of the uranium, *transmuting* the uranium into plutonium (see **Transmutation of elements**). Similar techniques were later used to produce other transuranium elements. In addition, Seaborg's isolation of plutonium 239, an isotope that readily undergoes *fission* (splitting) when struck by neutrons, served as the basis for the development of the plutonium atomic bomb (see **Plutonium**).

Seaborg was born in Ishpeming, Michigan. He received a Ph.D. in chemistry from the University of California in 1937. After World War II ended in 1945, he became active in the development of nuclear energy for peaceful purposes. From 1961 to 1971, he was chairman of the U.S. Atomic Energy Commission.

O. Bertrand Ramsay

Related articles in *World Book* include:

Americium	Einsteinium
Berkelium	Mendelevium
Californium	Nobelium
Curium	Transuranium element

Seaborgium is an artificially produced radioactive element with 106 protons—that is, with an *atomic number* of 106. Scientists have found six *isotopes* of seaborgium, forms of the element with the same number of protons but different numbers of neutrons. The *atomic mass numbers* (total numbers of protons and neutrons) of these isotopes are 259, 260, 261, 263, 265, and 266. The most stable isotope has an atomic mass number of 266 and a *half-life* of 20 seconds—that is, due to radioactive decay, only half the atoms in a sample of isotope 266 would still be atoms of that isotope after 20 seconds.

In 1974, scientists at the Joint Institute for Nuclear Research in Dubna, near Moscow, first announced the production of the element. Dubna was then part of the Soviet Union and is now in Russia. The Soviet scientists had bombarded lead, whose atomic number is 82, with chromium, whose atomic number is 24. Later in 1974, scientists at two California laboratories now known as Lawrence Berkeley National Laboratory and Lawrence Livermore National Laboratory made a rival claim for the discovery of the element. Both groups of scientists had bombarded californium, whose atomic number is 98, with oxygen, which has an atomic number of 8.

In 1986, the International Union of Pure and Applied Chemistry (IUPAC) and the International Union of Pure and Applied Physics formed a working group to review the histories of the elements with atomic numbers from 101 to 109. In 1993, IUPAC accepted the working group's conclusion that the California laboratories deserved credit for the discovery of the element. Disagreements about what to name the element delayed an official naming until 1997, however. Before being named, seaborgium was commonly referred to as *element 106.*

Seaborgium is named for American chemist Glenn T. Seaborg, who shared in the discovery of several elements. The symbol for seaborgium is Sg.

Richard L. Hahn

Seafood is the flesh of fish, mollusks, and shellfish that is eaten as food. Seafood makes up a major part of people's diet in countries where it is abundant, such as the island nations of Iceland, Japan, and the Maldives. In other countries, people eat seafood to add variety to their meals. Certain people also eat it to help reduce their intake of the fatty substance *cholesterol.*

Seafood is sold fresh, frozen, canned, smoked, pickled, or cured. Popular fresh or frozen seafood includes

clams, cod, crab, pollack, salmon, sardines, shrimp, squid, and tuna. Many kinds of fish and shellfish are sold whole. Large fish are often cut up and sold as boneless *fillets,* or as cross-section pieces called *steaks,* which include bones. Fresh or frozen fish is often sold battered or breaded. Popular canned fish include salmon, sardines, and tuna. Another popular seafood item is *surimi,* minced fish that is processed into imitation crab, shrimp, and other shellfish for use in seafood salads.

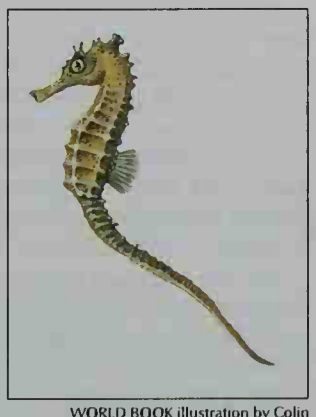
Fish is often served baked, grilled, steamed, or fried. A piece of fish should be cooked 10 minutes for every inch (2.5 centimeters) of its thickness. Shellfish is often boiled or deep fried. A popular Japanese dish, *sushi,* is carefully prepared using fresh raw fish.

Seafood contains many *nutrients* (nourishing substances) needed by the human body. Most seafood is high in protein, vitamins, and minerals, and low in calories, cholesterol, and sodium. Many seafoods are a good source of vitamins B_6 and B_{12} and also contain two other B vitamins known as *niacin* and *riboflavin.* Fish contain a special kind of fatty acid called *omega-3,* which many scientists believe can reduce a person's risk for heart disease and other illnesses. Minerals provided by various types of seafood include calcium, copper, iodine, iron, magnesium, phosphorus, potassium, selenium, and zinc.

Species used for seafood may be captured by commercial fishing crews or by amateur fishing enthusiasts, or they may be raised by fish farmers in a process called *aquaculture.* Worldwide demand for seafood is constantly increasing, but stocks of many commercial fish species are declining. Aquaculture helps meet the demand. Major food fish taken by the fishing industry include anchovies, cod, hake, haddock, herring, mackerel, pollock, salmon, sardines, and tuna. Clams, crabs, mussels, octopus, oysters, scallops, shrimp, and squid are among the leading types of shellfish and mollusks taken by the fishing industry. Major kinds of fish, mollusks, and shellfish raised through aquaculture include amberjack, carp, catfish, clam, mussels, oysters, salmon, shrimp, tilapia, and trout. Michael L. Jahncke

See also **Aquaculture; Fishing industry.**

Seahorse is a small fish that is so named because its head resembles that of a tiny horse. About 25 species of seahorses live in shallow tropical seas. Some are found in temperate waters. Most seahorses are less than 6 inches (15 centimeters) long. The *Pacific seahorse* may be as long as 12 inches (30 centimeters). Seahorses belong to the same family as pipefishes (see **Pipefish**).



WORLD BOOK illustration by Colin Newman, Linden Artists Ltd.

Seahorse

A seahorse's body is made up of bony plates. The fish has a long snout and feeds by sucking small animals into its cylindrical mouth. The tail is long, flexible, and capable of grasping. Seahorses use their tails to cling to rooted plants or floating sea vegetation. Baby seahorses often form small groups by holding onto each other. A seahorse's large *swim bladder* holds air and enables the fish to stay at a certain depth. A seahorse swims weakly, using its *dorsal fin* (back fin). It can move this fin back and forth 35 times a second.

Seahorses have an unusual way of reproducing. The male has a pouch in which the female lays from dozens to hundreds of eggs. The male carries the eggs for 10 to 45 days, depending on the species. He later releases tiny, live young. Seahorses do well in home aquariums. Leighton R. Taylor, Jr.

Scientific classification. Seahorses belong to the family Syngnathidae and are genus *Hippocampus.* The Pacific seahorse is *H. ingens.*

Seal is a sea mammal that has a sleek, torpedo-shaped body and flippers in place of legs. Seals have adapted to living both on land and in the sea. They are excellent swimmers and are especially graceful in the water. On land, some seals walk on all four flippers, but others move by hunching their bodies with their powerful stomach muscles, somewhat like a caterpillar.

Seals generally live along the edges of continents and islands. Most *species* (types) of seals live in the earth's polar and temperate zones, where the fish populations are largest. Seals live mostly in the oceans or inland seas, but a few species live in fresh water. For example, the Baikal seal lives in Lake Baikal in Russia.

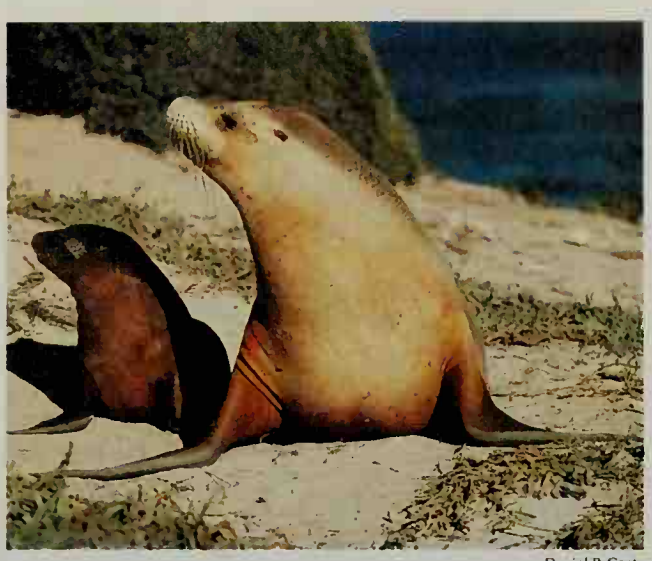
Seals belong to a group of animals called *pinnipeds.* This name comes from a Latin word meaning *fin-footed.* A seal's flippers look somewhat like fins. There are 34 different species of pinnipeds. They are divided into three main groups: (1) eared seals, which include fur seals and sea lions; (2) earless seals, including harbor seals and elephant seals; and (3) walruses.

Kinds of seals

Eared seals include fur seals and sea lions. They are called *eared seals* because they have ear flaps that cover their ear openings. Other seal species have uncovered ear openings. Another characteristic of these seals is that their hind flippers can be rotated forward and down, so that they can use all four flippers to walk on land. Fur seals and sea lions swim by using only their front flippers.

Facts in brief

Names: *male,* bull; *female,* cow; *young,* calf, pup, or whelp; *group,* herd or pod.
Gestation period: About 8 to 12 months, depending on the species.
Number of newborn: Usually 1, rarely 2.
Length of life: 40 years or more.
Where found: Along the coasts of most continents; a few kinds in freshwater lakes and inland seas.
Scientific classification: Seals make up a group of animals called the *pinnipeds.* Traditionally, they have been classified as a suborder of the order Carnivora, which includes such land mammals as bears, cats, and dogs. Some zoologists consider the seals a separate order, Pinnipedia. Fur seals and sea lions belong to the eared seal family, Otariidae. Earless seals make up the family Phocidae. Walruses belong to the walrus family, Odobenida. The northern elephant seal is *Mirounga angustirostris,* and the southern elephant seal is *M. leonina.* The harbor seal is *Phoca vitulina.* The hooded seal is *Cystophora cristata,* and the crabeater seal is *Lobodon carcinophagus.*



Daniel P. Costa

Seals have sleek bodies with flippers in place of legs. This picture shows a mother seal, an Australian sea lion, protecting her *pup* (baby seal). Female seals almost always give birth to only one pup at a time. The pup is covered by a soft fur. Sea lion pups have brown fur.

Eared seals live mainly in the northern Pacific Ocean and in coastal areas of the Southern Hemisphere. Fur seals have fur to insulate them from cold water, while sea lions rely on thick layers of blubber. Sea lions are larger than fur seals and have a broader, less pointy nose. Both species move well on land and often travel relatively far from shore.

Earless seals are different from fur seals and sea lions. These seals do not have ear flaps, but they do have ears. In fact, they have excellent hearing both above and below the water. Another important difference is that earless seals cannot use their rear flippers to walk on land. They pull themselves forward on their bellies, using their front flippers and powerful stomach muscles. On land, they do not move as fast as eared seals and cannot travel as far from shore. Earless seals use their hind flippers to swim using a side-to-side motion, like most fish. They can dive better than eared seals can.

Walruses are physically much different from other seals. For example, the walrus is the only seal with tusks. But walruses have features in common with both eared and earless seals. Like eared seals, walruses use their hind flippers to walk on land. Like earless seals, walruses have small ear openings but no outside ears. For more information about walruses, see the **Walrus** article in *World Book*.

The body of a seal

The largest pinniped is the southern elephant seal, which lives in the waters surrounding Antarctica. The male may grow 16 feet (5 meters) long and weigh up to 8,800 pounds (4,000 kilograms). This seal ranks second in size only to whales among all sea mammals. One of the smallest pinnipeds is the ringed seal. It usually grows about 3 $\frac{1}{2}$ feet (107 centimeters) long and weighs 110 to 200 pounds (50 to 90 kilograms).

Fur seals rely almost entirely on their thick coats of fine fur for insulation against the cold. Other seals rely on a protective layer of blubber that is often 1 to 6 inches (2.5 to 15 centimeters) thick.

Head. All seals have slitlike nostrils, which they can close when they swim underwater. Some kinds of seals have small heads with short noses. Adult male elephant seals have a long, curved nose that helps them attract mates.

The nose of a male hooded seal has a pouch that extends to the top of his head. When a competing male approaches, the seal inflates this pouch as a threat, making his head appear larger. An additional pouch inside the nostril also inflates, forming a bright red "balloon" that adds to the display.

Seals have large eyes and can see well in the dark. This ability enables them to feed at night or in deep water where there is little light. All seals have whiskers on their upper lip. The whiskers are sensitive to touch and probably help the animal find food.

Flippers. Seals have four legs, but the leg bones above the ankles do not extend outside the body. The ankles and feet form large, paddlelike flippers. The front flippers of fur seals and sea lions are longer and flatter than those of earless seals. A fur seal's front flippers may be more than 18 inches (45 centimeters) long and 6 inches (15 centimeters) wide.

The life of a seal

Seal rookeries. Seals go to their breeding grounds, called *rookeries,* to mate and to bear their young. More than 150,000 seals may gather at one rookery. The rookeries of earless seals can be on the shores of islands or continents. But all fur seal and most sea lion rookeries are on islands. Rookeries may occur on large sandy or rocky beaches.

Bull seals fight to establish territories within a rookery. They defend these territories and the cows within them. Young bachelors and older bulls without a *harem* (group of females) live apart from the others. Cow seals prefer to mate with the largest, most experienced males. Most cow seals bear their first young when they are 5 to 6 years old. They usually give birth every year after that. Some cow seals can give birth at 2 or 3 years of age. Some continue to bear young until they are about 25 years old.

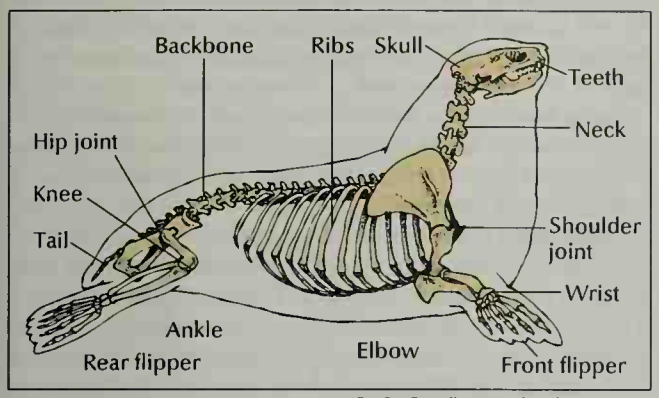
Birth. In all seal species, the young are conceived during one mating season and are born during the next. In most species, the embryo undergoes a period of *delayed implantation*—that is, it does not begin to grow in the mother's body until six weeks to five months after conception. Actual development of the young occurs over a nine-month period. A seal almost always has one *pup* (baby seal) at a time. Twins are rare.

A newborn pup is covered by a fine soft fur. Sea lion pups have brown fur, and newborn fur seals, elephant seals, and monk seals have black coats. The fur of baby harp seals, leopard seals, walruses, and other seals that live on floating islands of ice is usually white or grayish in color.

All seal pups are born in an advanced stage of development. Their eyes are open, and they can walk and vocalize within minutes of birth. Harbor seal pups can even swim within minutes of being born.

Raising young. Each seal species rears its pups differently. Most earless seal mothers remain at the rookery continuously from the birth of their pup until it is

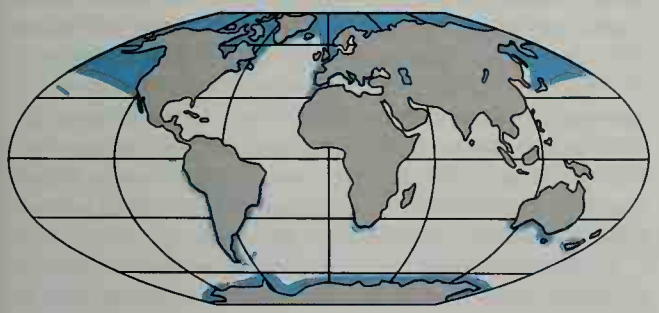
The skeleton of a seal



WORLD BOOK illustration by John D. Dawson

Where seals live

The blue areas of the map show the parts of the world where seals are found. Most seals live in the Northern Hemisphere.



weaned (able to eat regular food). During this time the seal cows do not feed. Some other seals, including harbor, ringed, and Weddell seals, do eat while rearing their young. For these species, weaning occurs abruptly when the mother leaves the rookery, leaving the pup behind. In some species, such as northern elephant seals, the pup remains at or near the rookery, not eating or drinking, for months after weaning.

Eared seal mothers divide their time between feeding at sea and nursing their pups on land. A mother may stay at sea for several days and then return to nurse her pup for 1 to 3 days. This cycle lasts from at least four months up to three years. But in most species, pups are weaned within a year of their birth.

Mother seals find their pups out of the hundreds of others at the rookery by calling out to them. When a pup hears its mother, it begins to call back. Each mother and pup have a unique call, and the mother responds only to her own offspring. Once together, the mother recognizes her baby by its smell.

Food. Seals feed on various marine animals. They have sharp, pointed teeth. They cannot chew food because their teeth have no flat surfaces. They swallow small fish whole or grasp and tear off pieces of larger prey.

Fur seals and sea lions eat primarily fish and squid. Harbor seals eat mostly fish and octopuses. Crabeater seals feed mainly on small, shrimplike creatures called *krill*. Elephant seals prefer fish and squid. Leopard seals feed on fish, penguins, and sometimes other seals.

Diving. Seals are excellent divers. They can dive deeper and longer than most other mammals because their bodies store more oxygen. Fur seals and sea lions, for example, can store twice as much oxygen as human beings can. Earless seals can store three times as much oxygen as human beings can. Fur seals and sea lions feed on prey near the surface, while earless seals feed on prey in deeper water and on the bottom.

Elephant seals exceed all other seals and even most whales in diving ability. They can dive about as well as the sperm whale, which is the deepest diving whale. Northern elephant seals dive continuously, day and night, for two to eight months. They spend an average of 20 minutes underwater per dive.

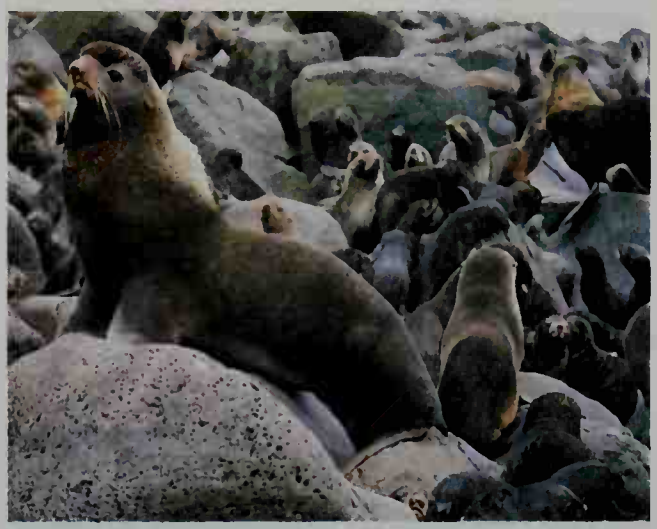
Enemies. Seals have few enemies besides human beings. Large sharks and killer whales attack them in the water, and polar bears hunt seals on ice. A seal has few defenses against its enemies. In the water, it usually tries to escape an attacker. A frightened fur seal can swim as fast as 10 miles (16 kilometers) per hour for about five minutes. Some species swim among the strong waves and between the large rocks close to shore, where most of their enemies cannot go. Other species dive deep when an enemy approaches.

Many kinds of seals are so slow and clumsy out of the water that they have little chance of escaping an enemy. Crabeater seals are one of the fastest seals on land or ice. They can move about 15 miles (24 kilometers) per hour—almost as fast as a person can run.

People and seals

Seals in captivity. Fur seals and sea lions are the kinds of seals that most often perform in shows at circuses, zoos, and marine parks. These seals are more acrobatic and easier to train than other types of seals. Trained sea lions crave attention and enjoy performing. A strong bond often develops between sea lions and their trainers. Sea lions breed so well in captivity that many zoos and marine parks have had to control breeding to prevent overpopulation.

Hunting of seals. People have hunted seals for thousands of years. To the Inuit people of the Arctic, seals



Daniel P. Costa

A male Northern fur seal guards his territory at a *rookery*, or breeding ground. The fur seal's thick coat provides insulation against the cold. Like sea lions and walruses, fur seals can rotate their hind flippers forward and down to walk on land.

are an important source of food. Many peoples hunt seals for their fur, skin, and oil.

In many places, fur seals were hunted almost to the point of extinction. In 1911, Canada, Japan, Russia, and the United States signed an agreement to protect northern fur seals. Under the agreement, seals could be hunted commercially only on land.

Since the 1970's, the demand for seal fur has declined as people became more concerned about the welfare of the animals. A combination of the declining market for furs and pressure from environmental groups helped to end the commercial harvest of fur seals on the Pribilof Islands in 1986. However, thousands of young male fur seals are still harvested each year for food by residents of the Pribilofs.

Seals and fishing crews. In some cases, seals and fishing crews compete for the same fish. In the Ballard Locks near Seattle, for example, California sea lions have learned that salmon are easy to catch when the fish approach the artificial waterways called fish ladders. Salmon use these fish ladders when swimming around the locks. The sea lions eat so many of the salmon that the local salmon population has seriously declined. This decline has reduced the local salmon harvest.

However, seals are often blamed for reductions in fish harvests that may actually be due to overfishing. It is also possible that seal populations are shrinking because fishing by humans is reducing the animals' food supply.

Threats to seal populations include the destruction of their habitats due to increased use of coastal resources and the expanded use of the ocean for recreation. Seals are often accidentally caught in fishing nets. Many seals also get entangled in discarded plastic packing straps and discarded or lost fishing gear. This problem grows worse over time, as many of these discarded products do not break down from the action of microbes in the water and so last for years. As human populations increase, people will likely disturb more seal rookeries. Daniel P. Costa

Related articles in *World Book* include:
Alaska (Fur industry; picture: Northern fur seals)
Animal (picture: Fur seals)
Antarctica (Animal life)
Bering Sea controversy
Inuit
Pribilof Islands
Territoriality
Walrus

Additional resources

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Seal is a device with a design or lettering for *impressing* (stamping) on paper, wax, or metal. Seals are often attached to official and important documents to prove that they are trustworthy. Most countries in the world and many cities, states, provinces, important officials, and commercial enterprises have seals.

The *matrix* (mold) of a seal may be made of paper, metal, or gem. It may consist of two pieces, the *baso* (bottom) and *alto* (top). The matrix is used for stamping one design on paper. It can also be used to stamp different designs on the *obverse* (front) and the *reverse* (back) of wax or lead. In early times, kings and other officials wore signet rings. They pressed the design of the ring on hot wax to make a seal. Whitney Smith

For a description and picture of each state seal in the United States, see each state article. See also **Babylonia** (Art); **Great Seal of the United States; President of the United States** (picture).

Sealyham terrier is a strong, white, short-legged dog with a long head, powerful jaws, and big teeth. It is good at catching rats and mice. This dog stands about 11 inches (28 centimeters) high and weighs 23 to 25 pounds (10 to 11 kilograms). The Sealyham terrier was first bred about 1850 at Sealyham, an estate in Pembrokeshire, Wales. It was once used in Wales to frighten badgers, foxes, and otters from their burrows. If necessary, it would go into the burrow and drag the animal out. Critically reviewed by the American Sealyham Terrier Club

See also **Dog** (picture: Terriers).

Seaman, Elizabeth Cochrane. See **Bly, Nellie.**

Seamount is a volcano that forms on the ocean floor. There may be as many as 1 million volcanoes on the Pacific Ocean floor alone, roughly 750 times the number on dry land. Seamounts occur throughout the ocean, wherever *magma* (melted rock inside the earth) rises to the sea floor and erupts. These submerged volcanoes form in deep basins, in areas near the continents, and at the mid-ocean ridges where *lava* (magma that has erupted) hardens into new sea floor material.

A typical seamount is cone-shaped, with a circular or almost circular base. It may form with a sharp peak or a flat top. Either kind of seamount may have a crater at the top. A crater forms if the hot rock under the top drains away, leaving a large part of the top unsupported. The top then collapses, producing the crater. Some islands sink beneath the oceans as they age. Waves may plane off their tops as they sink, producing flat-topped, submerged volcanoes called *guyots.*

Seamounts come in all sizes, but most are less than

Woods Hole Oceanographic Institution

A seamount formed when lava erupted from the floor of the Atlantic Ocean. Its crater rises about 720 feet (220 meters) above the floor and measures about 1,970 feet (600 meters) across.

1,600 feet (500 meters) high. A seamount that grows tall enough to break the surface of the ocean is called an *oceanic island* or *volcanic island.* In some regions, seamounts must reach a height of at least 16,000 feet (5,000 meters) before breaking the surface.

The Hawaiian Islands are oceanic islands—and another Hawaiian island is in the making. About 19 miles (30 kilometers) southeast of the island of Hawaii, Loihi (pronounced *loh EE hee)* Seamount is erupting and increasing in height. Its summit is about 3,300 feet (1,000 meters) below the surface of the ocean. It may break the surface in about 50,000 years. Deborah K. Smith

Search, Right of. See Right of search.

Search warrant is a document issued by a court to permit a police officer to search a house, automobile, locker, or any other specified place. It is issued if there is reasonable cause to believe that illegal materials, such as gambling devices, burglar tools, or illegal drugs, are hidden there. A search warrant may also be issued to search for people.

In the Constitution of the United States, Amendment 4 states that no unreasonable searches or seizures may be made. The cause of search must be supported by oath. The search warrant must describe the place to be searched and what is to be seized in the search. The Supreme Court of the United States, however, allows exceptions. In 1982, the court ruled that police do not need a search warrant to accompany an arrested person into the person's home or to seize any possible criminal evidence in sight there. In 1984, the court declared that evidence obtained with a search warrant later ruled to be defective may be used in court if the police reasonably believed they followed proper procedures in obtaining the search warrant. James O. Finckenauer

Sears, Roebuck and Co. is one of the largest retail companies in the United States. Sears operates hundreds of department stores and specialty stores in the United States, Canada, and Mexico.

In 1886, Richard W. Sears, a railroad station agent in his early 20's, began to sell watches by mail from North Redwood, Minnesota. Sears moved to Chicago the next year and hired Alvah C. Roebuck to repair customers' watches. The two men became partners and in 1893 founded Sears, Roebuck and Co. The company sold clothing, household goods, farm implements, and many other kinds of products, all by mail-order catalog. The first catalog was published in 1888. In the early 1900's, Sears became the world's largest mail-order company.

In 1925, Sears opened its first retail store, in Chicago. That store was quickly followed by many others. In 1931, sales from the firm's retail stores topped its mail-order sales for the first time. That same year, the firm founded the Allstate Insurance Company, which became one of the largest insurers of homes and automobiles in the United States. Sears also became active in real estate and financial services, acquiring *affiliates* (branch organizations) in both fields in 1981.

In the 1990's, financial troubles prompted Sears to eliminate or cut back many of its activities. The firm sold its financial services and real estate affiliates in 1993. It also closed many of its retail stores and eliminated its famous mail-order catalog. In 1995, Sears sold the Allstate Insurance Company.

Today, Sears sells a broad range of general merchandise and services through its retail stores and its direct marketing branch. The retail stores include department and specialty stores. The company's direct marketing branch sends advertising to customers through the mail.

In the early 1970's, Sears built the Sears Tower, then the world's tallest building, in Chicago. The building housed the company's corporate headquarters until 1995. That year, Sears moved its headquarters to the Chicago suburb of Hoffman Estates. John C. Schmeltzer

See also Mail-order business; Retailing.

Sears Tower, in Chicago, is one of the tallest buildings in the world. It has 110 stories, reaching 1,450 feet (442 meters) high. Twin antenna towers on top of the Sears Tower bring the total height to 1,707 feet (520 meters).

The Sears Tower stands on South Wacker Drive between Adams Street and Jackson Boulevard. The building consists primarily of business offices and some retail stores. About 1 $\frac{1}{2}$ million people visit the Sears Tower each year. An observatory on the 103rd floor called the Skydeck is open to the public. On a clear day, visitors can see four states—Illinois, Indiana, Michigan, and Wisconsin.

The Sears Tower has a black exterior made of aluminum and glass. The inside measures about 4.5 million square feet (0.42 million square meters) and includes about 3.5 million square feet (0.33 million square meters) of office space. It has more than 100 elevators. The Skydeck elevator can travel to the 103rd floor in 70 seconds. The building uses about as much electric power as a town of 35,000 people.

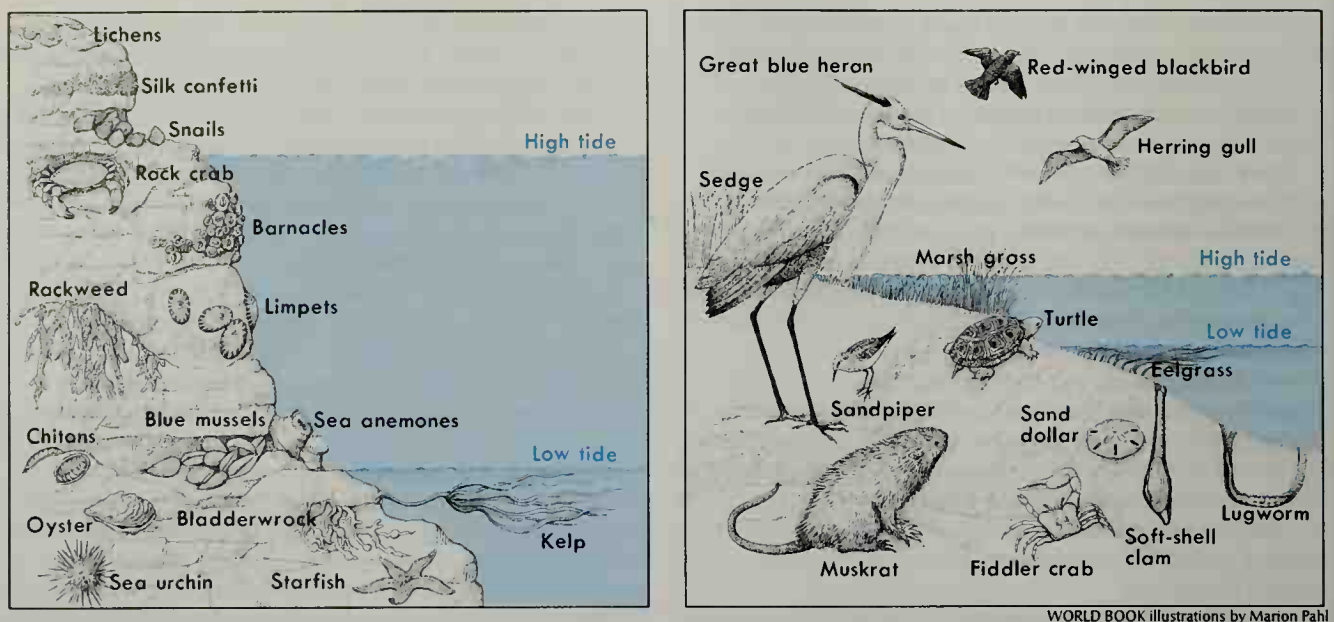
The Sears Tower was built by Sears, Roebuck and Co. Construction on the building began in 1970 and was completed in 1973. It cost $160 million. The structure was designed by the architectural firm of Skidmore, Owings & Merrill. John J. Zils

See also Chicago (picture); Skyscraper.

Seashore is the place where the land and the sea meet. It is an area of continual change. As the sea rolls in at high tide, much of the shore becomes part of the ocean. At low tide, the sea retreats and the same area again becomes part of the land. But in spite of this ever-changing environment, the seashore supports a great variety of living things. Many of these organisms live nowhere except along the ocean's edge.

A mass of tiny organisms, called *plankton,* play an important role in the life of the seashore. These organisms swim or float on the ocean tide. Many of them remain part of the plankton for their entire life, but others grow into larger animals of the seashore. Most large seashore animals start their existence as *larvae,* planktonic creatures that bear little resemblance to their parents. Most larvae die, but some of them land on a suitable shore and grow into adults.

As ocean waves sweep across the shore, they carry with them a feast of plankton. Many seashore animals feed on these tiny organisms. Such creatures as barnacles, mussels, oysters, and sponges spend their adult life permanently attached to the shore. These shore animals eat the plankton when it comes to them. Other kinds of animals, including clams and worms, burrow into the shore and collect food from water containing plankton. Even shorebirds that feed on the plankton-eating creatures rely indirectly on the plankton.



WORLD BOOK illustrations by Marion Pahl

Life along the seashore. Rocky coasts, *left,* support more organisms than any other type of seashore. Birds and mammals visit muddy shores, *right,* to feed on creatures that live there.

Scientists classify seashores into three main types, depending on their surface: (1) rocky shores; (2) muddy shores; and (3) sandy shores. Characteristic groups of organisms live on each type of shore.

Life on rocky shores is more plentiful than on any other type of seashore. Great numbers of organisms crowd the hard, rough surfaces of coral reefs and wave-scarred cliffs. They must withstand powerful waves that could wash them away or crush them on the rocks.

Most organisms that live on rocky seashores have special features that hold them securely to the rocks and coral. Many adult animals, including barnacles, mussels, oysters, sea squirts, and sponges, permanently anchor themselves to the shore. Others, such as chitons, limpets, sea anemones, sea urchins, and starfish, also attach themselves firmly to the shore. But these creatures are capable of moving short distances.

Some animals, including plantlike *bryozoans* and *hydroids,* have flexible bodies that bend with the motion of the waves. Large seaweeds, such as *kelps* and *rockweeds,* cling to the shore with structures called *holdfasts.* Many species of worms and other creatures burrow into the rock and coral, and others jam themselves tightly into cracks.

When the tide goes out on a rocky shore, small pools of water remain behind. These *tide pools* provide a refuge for crabs, fish, and other seashore creatures that need to remain in seawater. Such animals live in the tide pools until the incoming tide again covers the shore.

Most animals that live on rocky shores eat plankton. A few, including rock crabs and starfish, feed on the creatures that eat the plankton. Water plants and algae create their own food in a process called *photosynthesis* (see Photosynthesis).

Life on muddy shores. Most muddy seashores lie in bays, where they are protected from strong waves. Rivers empty into many of these bays, decreasing the saltiness of the sea water. Plants—including grasses and, in the tropics, mangrove trees—thrive along the shores. Crabs and turtles live among these plants. Clams and worms burrow into the muddy bottom of the seashores.

Life on sandy shores. Sandy beaches have fewer forms of life than do rocky or muddy shores. Most plants and animals cannot attach themselves strongly enough in the loose sand to withstand the effects of waves and currents. Most animals of sandy shores—including clams, crabs, and sand dollars—burrow under the sand. Few plants live on sandy shores between the levels of high and low tide. David L. Garrison

See also Ocean (Life in the ocean; Waves).

Seasickness. See Motion sickness.

Season is one of the four periods of the year. Each season—spring, summer, autumn, and winter—lasts about three months and brings changes in temperature, weather, and the length of daylight.

During the spring, the days are warm in middle parts of the Northern Hemisphere, the northern half of the earth. Summer follows with hot days and warm nights. In autumn, days become cooler, leading to winter. The four periods are called *climatic seasons* when based on these temperature and weather changes.

In the Southern Hemisphere, the climatic seasons differ by about six months. This hemisphere has summer when the Northern Hemisphere has winter.

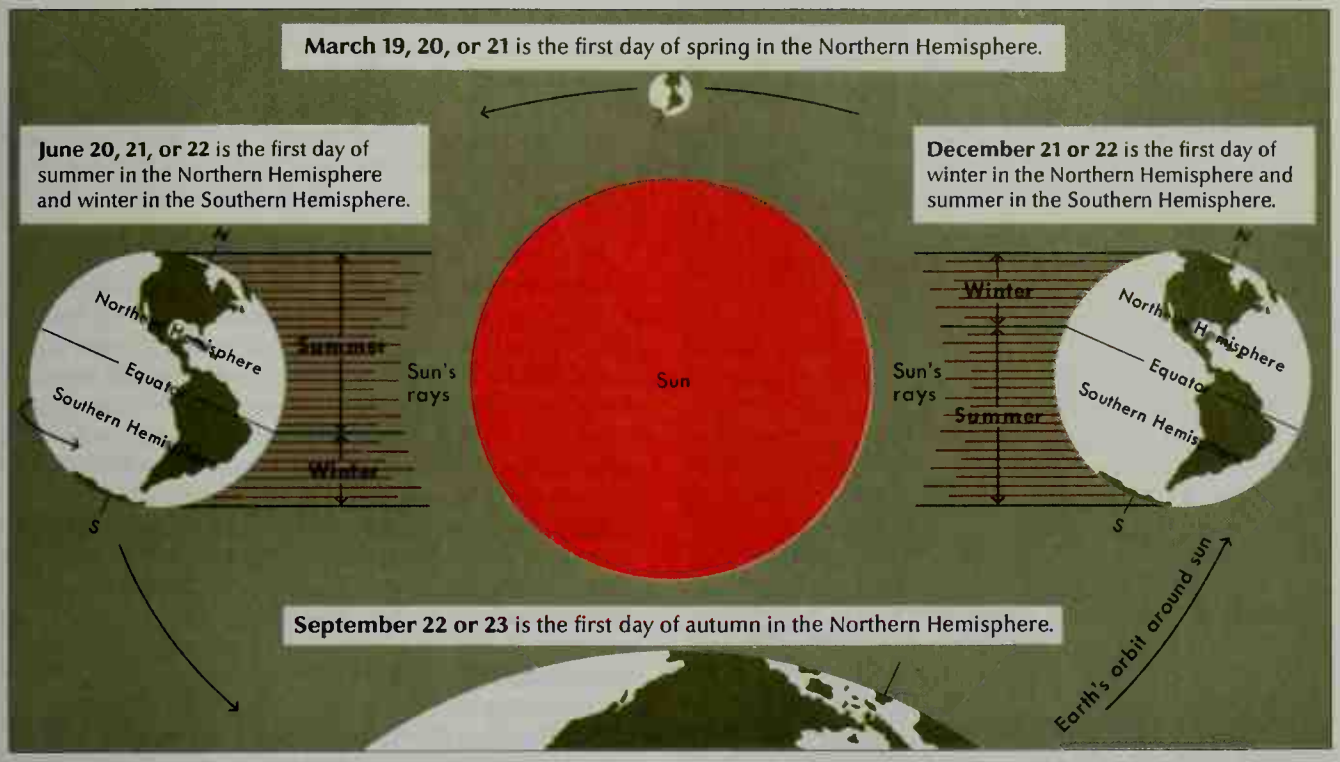
Some regions do not have all four climatic seasons. In parts of the tropics, for example, temperatures change little. But the amount of rainfall varies greatly, so that these regions have a wet season and a dry season. The polar regions, on the other hand, have a light season and a dark season. In these areas, the sun shines almost all the time in summer and almost never in the winter.

The changing seasons are caused by the changing position of the earth in relation to the sun. The dates used for the first day of each season mark the beginning of the *astronomical seasons.* The beginning and end of the climatic seasons vary from these dates from place to place and from year to year. The temperature and weather do not change instantly in response to the changing position of the earth in relation to the sun. The warmest and coldest weather generally occurs several

The change of seasons

The seasons change because the tilt of the earth's axis causes places on the earth to receive different amounts of sunlight during the year. When the North Pole has its greatest slant toward the sun, summer begins in the Northern Hemisphere. The sun's rays strike the earth from a high angle, and northern areas receive maximum sunlight. When the pole has its greatest tilt away from the sun, winter begins in the Northern Hemisphere. The rays come from a low angle, supplying minimum light. As the earth moves halfway between these positions, autumn and spring begin.

WORLD BOOK diagram



weeks after the beginning of the summer and winter astronomical seasons. The delays occur because the oceans require much time to warm up in summer and cool down in winter.

The seasons keep changing because the tilt of the earth's axis never changes while the earth circles the sun. One way to understand this is to picture which way the tilt of the axis causes the North Pole to slant at different times of the year.

In the Northern Hemisphere, summer begins on June 20, 21, or 22, when the North Pole has its greatest slant toward the sun. The moment at which the pole has this slant is called the *summer solstice* in the Northern Hemisphere. On the first day of summer, the sun is high in the sky, and there are more minutes of daylight than on any other day.

Winter begins in the Northern Hemisphere on December 21 or 22, when the North Pole has its greatest slant away from the sun. The moment at which the pole has this slant is known in the Northern Hemisphere as the *winter solstice*. On the first day of winter, the sun is low in the sky, and there are fewer minutes of daylight than on any other day.

In the Northern Hemisphere, the *vernal equinox* marks the beginning of spring, on March 19, 20, or 21. On this day, the North Pole starts to slant toward the sun. Autumn begins on September 22 or 23, the day of the *autumnal equinox*, when the pole starts to slant away from the sun. At both equinoxes, the sun appears directly above the equator. Places on the earth have approximately 12 hours of daylight and 12 hours of darkness.

John E. Kutzbach

First day of the astronomical seasons in the Northern Hemisphere*

Year	Spring	Summer	Autumn	Winter
1996	March 20	June 20	Sept. 22	Dec. 21
1997	March 20	June 21	Sept. 22	Dec. 21
1998	March 20	June 21	Sept. 22	Dec. 21
1999	March 20	June 21	Sept. 23	Dec. 22
2000	March 20	June 20	Sept. 22	Dec. 21
2001	March 20	June 21	Sept. 22	Dec. 21
2002	March 20	June 21	Sept. 22	Dec. 21
2003	March 20	June 21	Sept. 23	Dec. 22
2004	March 20	June 20	Sept. 22	Dec. 21
2005	March 20	June 21	Sept. 22	Dec. 21
2006	March 20	June 21	Sept. 22	Dec. 21
2007	March 20	June 21	Sept. 23	Dec. 22
2008	March 19	June 20	Sept. 22	Dec. 21
2009	March 20	June 20	Sept. 22	Dec. 21
2010	March 20	June 21	Sept. 22	Dec. 21

*Central Standard Time. In the Southern Hemisphere, the astronomical seasons differ by six months. For example, spring begins there when autumn begins in the Northern Hemisphere.
Source: U.S. Naval Observatory, Astronomical Applications Department.

Related articles in *World Book* include:

Autumn	Solstice
Calendar	Spring
Equinox	Summer
Indian summer	Winter

Additional resources

Markle, Sandra. *Exploring....* 4 vols. 1984-1991. Reprints. Avon, 1991-1993. One title covers each season; for example, *Exploring Spring.* Younger readers.
The Wildlife Year. Reader's Digest, 1993.

Seasonal affective disorder is a disturbance of mood that occurs with a change in season. The name is often abbreviated SAD. The best-known form, called

winter depression, occurs during the fall or winter. The most common symptoms include sadness, irritability, sleeping and eating much more than usual, poor concentration, fatigue, aches and pains, and severe anxiety. The symptoms go away in the spring. Doctors make a diagnosis of SAD only when symptoms occur in three different years or at least two years in a row.

SAD is caused by the shortening of the period of daylight during fall and winter. In the Northern Hemisphere, SAD is usually more common among people who live farther north where winter daylight is shorter.

Most victims of SAD suffer their first episode as teenagers or young adults, but some cases begin during childhood. Students with SAD may do well at the beginning and end of the school year, but they may perform poorly from October or December to April or May. Teachers and parents sometimes mistake SAD symptoms for misbehavior. Similarly, the job performance of adults with SAD may suffer during the fall and winter.

SAD may be treated with high-intensity, bright artificial light or with medication. Treatment with bright light requires special fluorescent tubes that emit light similar to sunlight. SAD patients receive this treatment for one or two hours each day. Improvements in the patient's condition generally occur after a few days to two weeks. SAD also can be treated effectively with antidepressant drugs. Steven C. Dilsaver

SEATO. See Southeast Asia Treaty Organization.

Seattle is a beautiful city in Washington state with spectacular views of high mountains and sparkling coastal waters. It is Washington's biggest city and the heart of a large metropolitan area. Seattle is also a manufacturing, trade, and transportation center for the Pacific Northwest.

Seattle lies on the east shore of Puget Sound, an arm of the Pacific Ocean. A channel called the Strait of Juan de Fuca links Puget Sound with the ocean. Seattle was founded in 1852 by settlers from Illinois. They named the town for Chief Sealth (also spelled *Seatlh* or *Seattle*), a Salish Indian who befriended them. The city grew as a center for producing lumber from Washington's forests and shipping it to many markets. A variety of other economic activities also developed. In the 1900's, the Seattle area became a center of aircraft and spacecraft manufacturing and other high-technology industries.

The city

Seattle covers 86 square miles (223 square kilometers) in King County. The downtown area extends east from Elliott Bay, an inlet of Puget Sound. So much water surrounds the downtown area that it seems like an island. In addition to Elliott Bay on the west, Lake Washington lies to the east and Lake Union and Union Bay to the north. During the last Ice Age, glaciers carved out hills and valleys that today form the city's setting. Seattle's hills rise over 500 feet (150 meters) above sea level.

In the late 1800's and early 1900's, major engineering projects reshaped Seattle's landscape. City engineers used high-pressure water jets to remove several hills, creating new flat land to allow expansion of the central business district. The soil from the hills was dumped into Elliott Bay or used to raise the level of low-lying areas called *tide flats* south of downtown. These areas, formerly covered with shallow water at high tide, be-

© Jim Corwin, AllStock

The Seattle skyline is framed between two towering landmarks—the lofty Space Needle, *left,* and snowy Mount Rainier, *right,* which appears to "float" on the horizon southeast of the city.

came dry enough for industrial development. Today, the tide flats serve as Seattle's chief manufacturing centers.

Floating bridges connect central Seattle with residential areas on the east side of Lake Washington. Ballard, a well-kept neighborhood northwest of downtown near the Lake Washington Ship Canal, has many residents of Scandinavian descent. Many Asian Americans live in the International District south of downtown.

Landmarks. Seattle's many hills provide striking views of the Cascade Mountains to the east and the Olympic Mountains to the west. The Cascades include famous Mount Rainier, which rises 14,410 feet (4,392 meters), about 60 miles (95 kilometers) southeast of Seattle. Visitors can also get good views of the region from the 76-story Columbia Seafirst Center downtown and from the Space Needle, an observation tower that rises 605 feet (184 meters) north of downtown.

The Space Needle served as the centerpiece for a 1962 world's fair called Century 21. Today, the Space Needle and other fair buildings make up a cultural complex called the Seattle Center. The complex includes the Opera House, the Bagley Wright Theatre, the Charlotte Martin Seattle Children's Theatre, and a science museum called the Pacific Science Center. A monorail built for the fair links the Seattle Center with downtown.

The Pioneer Square historical district includes many old brick buildings erected after a disastrous fire in 1889 destroyed most of Seattle's business district. Nearby, the Pike Place Market sells fresh fish and meat, local farm produce, and craftworks.

The metropolitan area of Seattle, according to the United States Census Bureau, covers King, Snohomish, and Island counties. The Census Bureau calls it the Seattle-Bellevue-Everett metropolitan area. Major cities in the area include Everett, Edmonds, and Lynnwood to the north of Seattle in Snohomish County; Bellevue, Redmond, and Kirkland to the east in King County; and Renton, Kent, and Auburn to the south, also in King County. Urban growth has spread west of Puget Sound into Kitsap County, which includes Bainbridge Island and the city of Bremerton; and south into Pierce County.

The Census Bureau groups the Seattle-Bellevue-Everett metropolitan area with the metropolitan areas of Bremerton, Olympia, and Tacoma to form the Seattle-Tacoma-Bremerton Consolidated Metropolitan Statistical Area. More than half of Washington's people live in this area. The four-county region of King, Pierce, Kitsap, and Snohomish is often called the Central Puget Sound Region.

People

Ethnic groups. About 70 percent of Seattle's people are white, and about 17 percent of the population has some Scandinavian ancestry. Blacks account for 8 percent of Seattle's population, and Asians and Pacific Islanders make up about 14 percent. American Indians make up about 1 percent of the population.

Housing. Slightly more than half of Seattle's housing consists of single-family homes. In the part of King County outside the city, single-family dwellings account for two-thirds of the housing. Suburbs with many elegant homes include Hunts Point, Bellevue, Mercer Island, and Newport Hills. Pleasant residential neighborhoods in the city include Laurelhurst, Madison Park, Magnolia, Queen Anne, and Washington Park. Waterfront or hillside locations with views of the mountains or Puget Sound are among the most desirable residential areas.

Facts in brief

Population: *City*—563,374. *Metropolitan area*—2,414,616. *Consolidated metropolitan area*—3,554,760.
Area: *City*—86 mi² (223 km²). *Metropolitan area*—4,425 mi² (11,461 km²). *Consolidated metropolitan area*—7,224 mi² (18,710 km²).
Climate: *Average temperature*—January, 43 °F (6 °C); July, 68 °F (20 °C). *Average annual precipitation* (rainfall, melted snow, and other moisture)—37 in (94 cm). To find the average monthly weather in Seattle, see Washington (Climate).
Government: Mayor-council. *Terms*—Four years for the mayor and nine council members.
Founded: 1852. Incorporated as a city in 1869.

Largest communities in the Seattle area

Name	Population	Name	Population
Seattle	563,374	Shoreline	53,025
Bellevue	109,569	Renton	50,052
Everett	91,488	Redmond	45,256
Federal Way	83,259	Kirkland	45,054
Kent	79,524	Auburn	40,314

Source: 2000 census.

Symbols of Seattle. The city's flag and seal bear the image of Chief Sealth, the Salish Indian leader for whom the city was named. Chief Sealth, also spelled *Seatlh* or *Seattle*, befriended the white settlers who founded the city. The flag was adopted in 1990.

Education. The Seattle School District operates about 100 public elementary and high schools that provide education to about 46,000 children. A seven-member elected school board oversees public education. The four-county Central Puget Sound Region includes about 850 public schools with a total enrollment of approximately 470,000. An additional 46,000 pupils attend about 250 parochial schools.

The University of Washington-Seattle is the region's largest institution of higher education. It is a major research, as well as instruction, center. Seattle Pacific University in Seattle, the University of Puget Sound in Tacoma, and a number of smaller colleges and universities also serve the region.

Social problems of Seattle are similar to those of other large urban areas. Crime, much of it associated with drug abuse and gang activity, is a major problem. Poverty and rapidly rising housing costs have contributed to a problem of homelessness in the city. In the 1950's, the Seattle area pioneered in water pollution control to protect the water quality of Lake Washington

and Puget Sound. As a result, water quality has greatly improved in the area. Air pollution, however, is a problem.

Cultural life

The Seattle area has a rich artistic tradition and offers a variety of cultural and recreational activities. Within an hour or two of driving time, Seattle residents can reach the Cascade or Olympic mountains, or the Pacific Ocean.

The arts. The Seattle Symphony, Seattle Opera, Seattle Repertory Theatre, and Pacific Northwest Ballet are among the largest artistic organizations in the region. Seattle has about 25 professional theater companies, more than any U.S. city except New York City and Chicago.

Some important artistic movements have developed in Seattle. For example, the Northwest School of painters, led by Morris Graves and Mark Tobey, created an elegant, Asian-influenced style of modern painting in Seattle during the 1930's and 1940's. In the 1990's, Seattle became the birthplace of a forceful style of rock music called *grunge*, which featured driving guitar chords.

Museums and libraries. The Seattle Art Museum divides its collection between two buildings. The larger of the two is a building in downtown Seattle designed by American architect Robert Venturi. The other is the Seattle Asian Art Museum in Volunteer Park. The Bellevue and Tacoma art museums also present major art exhibitions. Other important Seattle museums include the Museum of Flight at Boeing Field, the Burke Museum of Natural History and Culture at the University of Washington, and the Museum of History & Industry. The Experience Music Project, a museum devoted to American popular music, is in a building designed by American architect Frank Gehry. The museum's interactive exhibits offer visitors an opportunity to make their own music.

Both the city of Seattle and King County maintain library systems with branches throughout the city and county. The University of Washington has important col-

Seattle

Seattle is the largest city in the Pacific Northwest. The map at the right shows important points of interest in the city. The map below shows other communities in the area.

City boundary
County boundary
Expressway
Other road
Railroad
Point of interest
Park
Military area

Seattle geographical area

WORLD BOOK maps

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Mount Rainier National Park near Seattle attracts hikers and mountain climbers with its sparkling lakes, evergreen forests, and snow-capped Mount Rainier, Washington's highest peak.

lections for scholars specializing in Far Eastern and Russian studies and health sciences.

Recreation. The Seattle area has a mild climate, with cool summers and warm winters. This climate leads people to participate in outdoor activities the year around. Sailing, windsurfing, running, and biking are some of the most popular activities. Nearby outdoor recreation areas include three national parks—Mount Rainier, Olympic, and North Cascades.

Seattle has three professional sports teams. They are the Seattle Mariners baseball team of the American League, the SuperSonics of the National Basketball Association, and the Seattle Seahawks of the National Football League. Other popular sports include college football games at the University of Washington and hydroplane races on Lake Washington during the annual Seattle Seafair in July and August. These races feature high-speed motorboats that skim across the water.

The city of Seattle park system includes about 400 parks and other recreation areas. Parklands cover about 6,200 acres (2,500 hectares), or about 10 percent of Seattle. Discovery, Magnuson, Seward, and Lincoln parks have large areas of shoreline. Woodland Park is the site of the Woodland Park Zoo and the Woodland Park Rose Garden. The Woodland Park Zoo and Tacoma's Point Defiance Zoo and Aquarium are highly regarded for providing natural habitats for animals. The Woodland Park Rose Garden is one of the country's test gardens for new varieties of roses. The Seattle Aquarium has an underwater viewing dome for observing the marine life of Puget Sound.

Economy

Service industries. The Seattle area is a major retail trade and health care center for the Pacific Northwest. Key centers for retail trade include downtown; the Northgate Shopping Center in the city; and such suburban malls as Alderwood in the northern suburb of Lynnwood, Southcenter in the southern suburb of Tukwila, and Bellevue Square in the eastern suburb of Bellevue. Seattle is also headquarters of Nordstrom, a national retail clothing company. Seattle's extensive health care facilities draw many people with specialized needs. A leading medical research center, the Fred Hutchinson Cancer Research Institute, is in the city.

Other big service industries include government and military activities. United States Navy facilities are important to the economy of Kitsap County. Army and Air Force bases are major employers in Pierce County.

Manufacturing. The area's major manufactured products include aircraft and software and other computer supplies. The Boeing Company, a leading maker of commercial airplanes and spacecraft, is the region's largest employer. Boeing has several assembly and research facilities in King and Snohomish counties. Many high-technology firms operate in the northeast suburb of Redmond. They include the Microsoft Corporation, a computer software company; and the U.S. headquarters of Nintendo, a Japanese producer of video games.

Transportation and communication. The Central Puget Sound Region serves as the transport hub of the Pacific Northwest area. The Seattle-Tacoma International Airport, often called Sea-Tac, handles domestic and international flights. Busy ports at Seattle and Tacoma are centers for goods shipped between the United States and Asia. Seattle has two daily newspapers, *The Seattle Times* and the *Seattle Post-Intelligencer.*

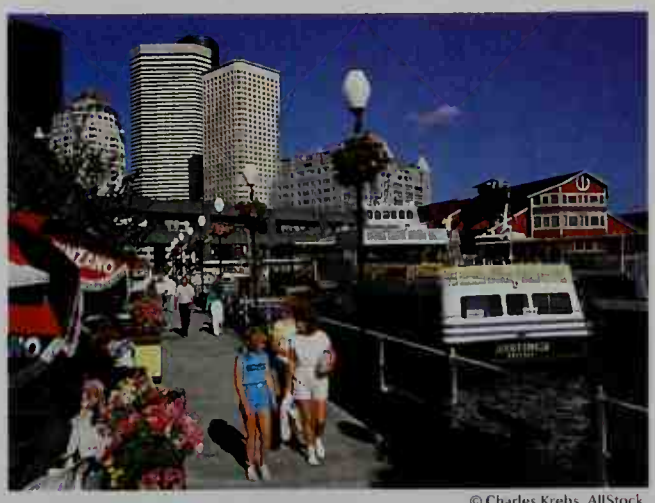
Government

Seattle has a mayor-council form of government. The people elect the mayor and the nine City Council members to four-year terms. The mayor is responsible for the operation of city departments and submits an annual budget for them to the City Council. City elections are *nonpartisan*—that is, candidates are listed on the ballot with no indication of their political party.

Almost half of the people of the Central Puget Sound Region live in unincorporated areas. These areas have no city governments, so county governments are their chief source of government services. Metro, a municipal corporation that handles sewage treatment and public transportation throughout King County, became part of the county's government in 1994.

History

Early settlement. Many Indian tribes lived in the



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Seattle's waterfront lies on Elliott Bay, an inlet of Puget Sound. Visitors flock there to watch the boats and visit the many waterfront restaurants, outdoor cafes, and import shops.

Seattle area before white settlers arrived. They included Duwamish, Snohomish, Suquamish, and other Indians of the Salish group. In 1851, settlers from Illinois led by Arthur A. Denny founded a town on Alki Point, a Puget Sound beach. The town was in the present-day neighborhood called West Seattle. In 1852, most of the settlers moved to the east side of Elliott Bay, at the present location of downtown Seattle. Henry Yesler, a lumberman, built a sawmill there the next year. Seattle soon became a center for making lumber from wood of Washington's forests and shipping it to boom towns of California, where gold had been discovered in 1848. Lumber became the basis of the local economy, and the manufacture of paper grew in importance. Seattle received a city charter in 1869. The population reached about 1,000 by 1870.

Railroads and growth. The Puget Sound region's first rail link with the eastern United States was completed in 1883, when the Northern Pacific Railroad began service to Tacoma. In 1893, the Great Northern Railroad arrived in Seattle. The railroads brought settlers and opened national markets for the area's natural resources. The new markets led to massive expansions of the area's lumber and paper industries. Fire destroyed most of Seattle's business district in 1889. Nevertheless, the city's population grew to about 43,000 by 1890.

Economic expansion. Lumber milling remained the Seattle area's top economic activity until the early 1900's. But the area began to develop a more varied economy. The Klondike and Alaska gold rush of 1897 and 1898 brought thousands of settlers to the Puget Sound region, which was on the route to the gold-mining areas. Seattle's population soared to about 237,000 by 1910. The ports at Seattle and Tacoma grew into centers of international shipping after the opening of the Panama Canal in 1914. Agriculture and fishing, particularly salmon fishing, also increased in importance. In 1916, William Boeing started the Boeing Company, which soon became a leading aircraft maker.

After the United States entered World War I in 1917, Seattle began producing defense materials. The aircraft, lumber, and shipping industries flourished. Workers flocked to the city, and labor unions gained strength. After the war ended in 1918, the unions feared that they would lose ground because defense industries would need fewer workers. To protest the power of industry management, over 60,000 workers staged a five-day strike in February 1919. The strike, called the "Seattle Revolution of 1919," was the nation's first general strike.

Seattle also thrived during World War II (1939-1945). The aircraft industry boomed, and several shipbuilding companies were established. The industrial surge attracted many more newcomers to the city. The population rose from 368,000 in 1940 to more than 467,000 in 1950. By 1960, Seattle had 557,000 people.

In 1962, the Century 21 world's fair helped promote tourism in Seattle. The fairgrounds and buildings, now called Seattle Center, are still a year-round civic and tourist complex.

In Seattle, as in other U.S. cities, large numbers of people moved from the central city to suburbs in the mid-to-late 1900's. By 1980, the city's population had dropped to about 494,000. It increased during the 1980's, however, reaching 516,000 by 1990.

In the late 1900's, a series of ups and downs in the aircraft industry, with resulting swings in employment, led to efforts to add variety to the economy. The efforts helped bring an increase in service industries, including tourism. The opening of the Washington State Convention and Trade Center in Seattle in 1988 and the Meydenbauer Events Center in Bellevue in 1993 also attracted more convention business to the region.

Recent developments. The population of Seattle continued to grow through the 1990's. By 2000, the city had a population of 563,000.

In February 2001, a powerful earthquake hit the Seattle area. Hundreds of people were injured, and estimates of property damage totaled billions of dollars.

In mid-2001, the Boeing Company moved its headquarters from Seattle to Chicago. But Boeing remained the Seattle area's largest employer. William B. Beyers

See also **Puget Sound; Tacoma; Venturi, Robert** (picture); **Washington** (pictures).

Seaweed is a name applied to almost any plantlike marine organism that is large enough to be seen with the unaided eye. Seaweeds can be found growing in underwater beds, floating on the sea surface, attached to rocks and piers, and washed up on shore.

Like most plants, seaweeds contain a green *pigment* (coloring matter) called chlorophyll. Chlorophyll enables seaweeds to make their own food through *photosynthesis,* the process by which plants and certain other organisms use energy from sunlight to turn carbon dioxide and water into sugar. This sugar not only fuels the seaweeds' own growth and development, it also serves as food for animals that feed on seaweeds. Seaweeds also help provide sea animals with oxygen, which is released as a by-product of photosynthesis. In addition, many marine creatures find shelter in seaweed beds.

Kinds. There are about 7,000 species of seaweeds. All of the species are simple organisms called *algae* (see **Algae**). Algae lack true roots, stems, leaves, and flowers. However, their special structure suits seaweeds to a life of pounding by the sea.

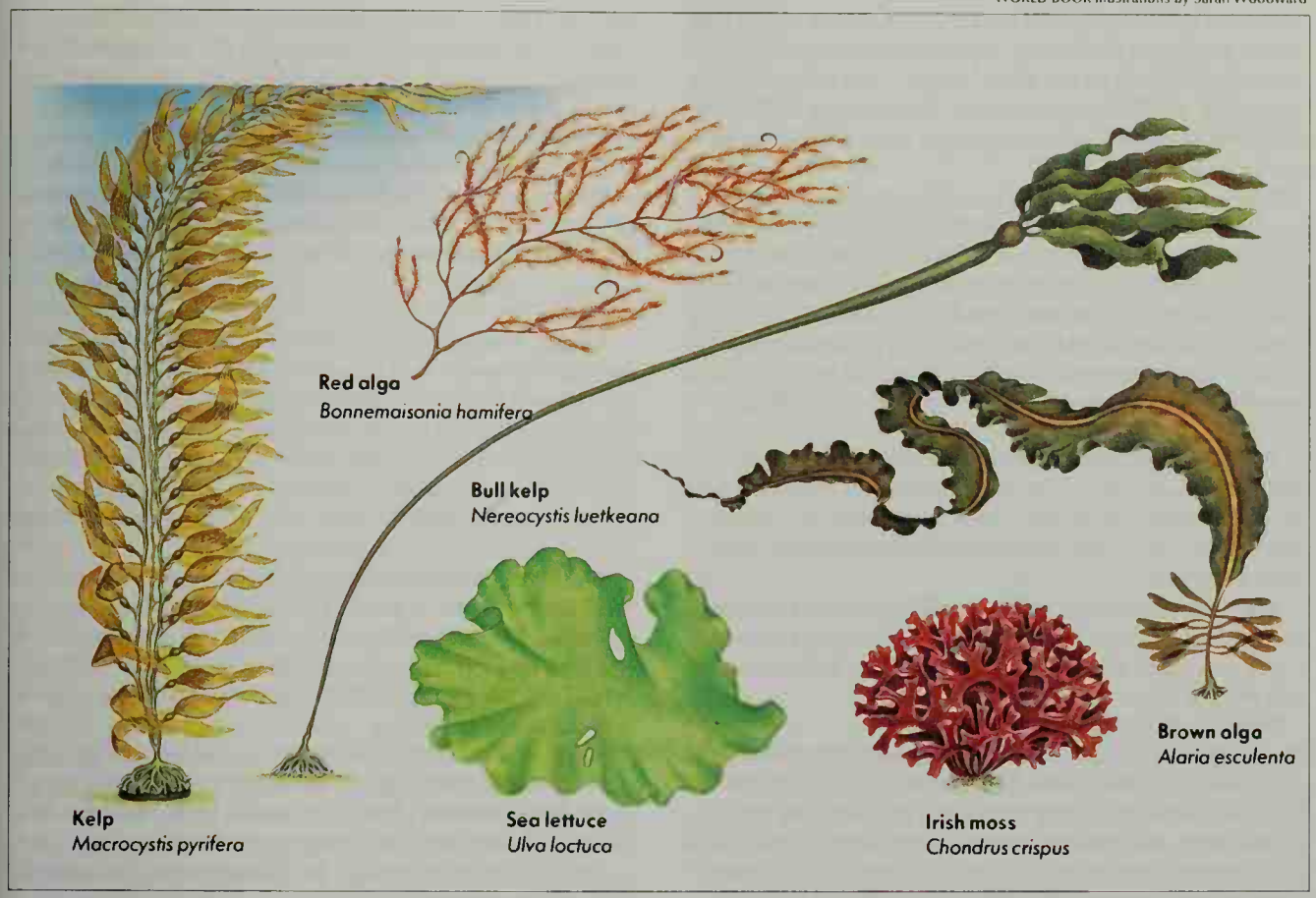
Marine algae can be found from the polar seas to the tropics. Most varieties grow near coasts, where they are attached to rocks, shells, or the floor of the sea. A rootlike part, called a *holdfast,* anchors larger seaweeds to solid objects and prevents them from being washed away. Unlike a true root, the holdfast is not specialized to absorb water and minerals.

A *stipe,* which resembles a stem, extends from the holdfast. The stipe connects the *frond,* which resembles a leaf, to the holdfast. The soft, flexible fronds of a seaweed can sway with the water without being torn apart. Some seaweeds have gas-filled swellings on their fronds. These swellings keep the frond afloat.

Seaweeds belong to the brown, red, and green algae groups. Most brown algae prefer cold water, where they may grow extremely large. For example, the *giant kelp* found off the coast of California reaches lengths of up to 200 feet (60 meters). Brown algae called *gulfweeds* prefer warm water. Gulfweeds grow in large, floating masses over an area of the North Atlantic Ocean known as the Sargasso Sea. Most red algae are small and delicate, with a feathery appearance. They prefer warm water, and they are particularly abundant in tropical and subtropical seas. Green algae grow in both warm and

Some types of seaweeds

WORLD BOOK illustrations by Sarah Woodward



cold seas. The greatest variety is found in shallow tropical waters. Most of these seaweeds are small.

Uses. The name *seaweed* incorrectly implies that these organisms have little value. Actually, many seaweeds are rich in vitamins and minerals and are eaten in various parts of the world. Seaweeds also have many industrial uses. Brown algae yield a gummy substance called *algin* and red algae produce jellylike substances called *agar* and *carrageenin.* Manufacturers add these substances to various foods and drugs to give them a smooth texture and help them retain moisture. Manufacturers also use algins in lipsticks, soaps, photographic film, paint, varnish, and buttons. Agar serves as a *culture medium,* a base on which bacteria are grown in scientific laboratories. See **Bacteriology** (Studying bacteria).

Scientific classification. Algae, including the common seaweeds, traditionally have been classified in the plant kingdom, Plantae. Today, many scientists classify these organisms in the kingdom Protista. The giant kelp is *Macrocystis pyrifera.* Gulfweeds make up the genus *Sargassum.* C. J. Hillson

Related articles in *World Book* include:

Aquaculture
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Kelp
Sargasso Sea
Seashore
Water plant

Sebastian, *sih BAS chuhn,* **Saint** (died A.D. 288), was an early Christian martyr. Legends about him were made famous by painters of the Renaissance. According to these legends, Saint Sebastian entered the Roman Army without revealing his intent to assist and protect the Christians. The Emperor Diocletian liked him and made him commander of soldiers in Milan. But Sebastian's religious faith was discovered, and he was condemned to death. A troop of soldiers tied him to a tree and shot him with arrows. They thought him dead and left him. He was cared for by a Christian woman named Irene. Sebastian again declared his faith after he recovered. The emperor then ordered him clubbed to death in the amphitheater, and he was buried in the catacombs. Saint Sebastian tied to the tree was a favorite subject of early Italian painters. His feast day is January 20.

Stanley K. Stowers

Sebastopol. See Sevastopol.

Secession. See Civil War.

Second, a unit in the metric system, is used to measure time and angles. Its symbol is s. In measuring time, 60 seconds make up 1 minute. There are 60 minutes in 1 hour, and 24 hours in a day, and so a second is $\frac{1}{86,400}$ of a day. In measuring angles, 60 seconds make up 1 minute, and there are 60 minutes in 1 degree. A circle is divided into 360 degrees. Thus, a second is $\frac{1}{1,296,000}$ of a circle.

A second of time equals an exact fraction of a day. But days are not equal in length because the earth does not travel in a perfect circle around the sun. Therefore, measurements of time based on the day are not constants and cannot be used for scientific work. Scientists used an atomic clock in establishing a measurement standard for time. This device measures intervals of time according to the number of vibrations made by a certain type of radiation from a cesium atom. A second is defined as 9,192,631,770 times the vibration of such a radiation. Johnny B. Holmes

See also **Atomic clock; Minute.**

Second Amendment to the Constitution of the United States reads, "A well-regulated militia, being necessary to the security of a free state, the right of the people to keep and bear arms shall not be infringed." The amendment, part of the Bill of Rights, was proposed by Congress in 1789 and ratified by the states in 1791. However, many people, including legal scholars, disagree about its meaning.

Some people argue that the Second Amendment grants ordinary citizens the right to own guns. According to these people, Congress proposed the amendment so Americans could protect their country in emergencies or overthrow their government if they decided it had become too corrupt. Historians point out that Congress recommended the amendment in response to fears that the Constitution gave the government too much power.

Other people claim that the Second Amendment only grants the states the right to organize some of their citizens into state-run militias. They argue that the amendment therefore gives Americans in general no right to own firearms.

The Supreme Court of the United States has decided few cases involving the Second Amendment. However, it has generally allowed extensive federal and state control of firearms. Sanford Levinson

See also **Gun control.**

Secord, *SEE kawrd,* **Laura Ingersoll,** *LAW rah IHNG gur sawl* (1775-1868), was the most famous Canadian heroine of the War of 1812. During the war, she lived in Queenston, near the Niagara River in what is now southern Ontario. The Americans, British, and Indians were fighting for control of that area.

In June 1813, Secord overheard American soldiers planning a surprise attack on a small British military post at Beaver Dam, about 20 miles (32 kilometers) away. To warn the British, she walked all day through a dangerous wilderness on June 22. On June 24, the Indians, joined later by the British commander, ambushed the Americans in the Battle of Beaver Dam. The battle ended with the surrender of the Americans.

Secord's walk became a favorite story among Canadians about the War of 1812. Some writers added imaginative details to the actual event.

Secord was born on Sept. 13, 1775, in Great Barrington, Massachusetts. She moved to Canada as a young woman. She died on Oct. 17, 1868. Reginald Horsman

Secret police are used by certain governments and by dictators to control, terrorize, and spy on people. Although the existence of such police forces is rarely a secret, some of their activities are.

Joseph Fouché, minister of police under Napoleon I, established the modern secret-police system. During the 1930's, the German dictator Adolf Hitler developed a secret-police force called the *Gestapo* to eliminate opposition.

The political police of the Russian czars was called the *Okhrana.* The Communist leaders of the Soviet Union used the secret police as an important tool for keeping power. The Soviet secret-police force was reorganized several times and existed under a number of names. One of the most familiar of these names was the KGB.

Douglas L. Wheeler

See also **Gestapo; KGB; Police state.**

Secret Service, United States, is a government bureau that protects the president, the president's immediate family, and certain other government officials. The Secret Service also investigates the counterfeiting of certain United States government identification documents and U.S. and international currency, securities, and stamps; fraudulent use of false identification documents; the theft or forgery of U.S. government checks and bonds; and major fraud cases involving computers, automatic teller machines, telecommunications, electronic fund transfers, credit cards, or *debit cards.* Debit cards are used to charge purchases directly to a bank account.

Among the people protected by the Secret Service are the vice president, the president-elect, the vice president-elect, and their immediate families. Others include former presidents and their spouses, widowed spouses of former presidents until they remarry, children under 16 of former presidents, major presidential and vice presidential candidates, and—within 120 days of a presidential election—the candidates' spouses.

The Secret Service also guards some non-Americans. The service protects visiting heads of foreign governments and, by order of the president, other distinguished foreign visitors. In addition, the Secret Service protects U.S. representatives performing special missions in other countries.

The Uniformed Division of the Secret Service guards the White House Complex, the Main Treasury Building and Annex, and the official residence of the vice president in Washington, D.C. It also guards foreign diplomatic missions throughout the United States, its territories, and its possessions.

Congress created the Secret Service in 1865 to fight the counterfeiting of U.S. currency. The service began protecting the president in 1901, after the assassination of President William McKinley.

A director heads the Secret Service. Secret Service headquarters are in Washington, D.C. The agency has district offices in major United States and foreign cities.

Critically reviewed by the United States Secret Service

See also **President of the United States** (Guarding the President).

Secretarial work includes a variety of activities that help keep an office running smoothly and efficiently. Secretaries may work in commercial, educational, governmental, industrial, or professional settings. They may assist one person or provide secretarial help for a number of people.

Secretarial duties may include typing correspondence, word processing, editing, sorting mail, answering telephones, taking messages, managing records, scheduling, and using basic math. Many secretaries also coordinate office procedures, supervise other office support personnel, plan meetings, and use computers to organize and store information. Some take dictation or use shorthand.

Millions of people are employed as secretaries throughout the world. Some people begin working as secretaries after completing high school. However, many employers prefer to hire people for secretarial work who have earned a degree or certificate from a business school, community college, or university. People who wish to obtain positions as secretaries should

study such subjects as language arts, accounting, business administration, office management, and business law, as well as typing, computer software, and office technology. Secretarial positions in such fields as law and medicine require specialized training.

A large number of people begin their career in the secretarial field as word processors or receptionists. Typically, these workers advance to such positions as secretary, executive secretary, administrative assistant, administrative secretary, and office manager. Many secretaries also may advance into managerial positions.

J. A. Heitman

Secretariat. See United Nations; League of Nations.

Secretary-bird is a tall African bird that has long feathers on the back of its head. The bird's name comes from these feathers, which suggest the quill pens secretaries and clerks once carried behind their ears. The secretary-bird stands over 40 inches (1 meter) tall, with long legs and a long tail. The bird is mostly gray with black feathers on its upper legs. Its eaglelike face is red to orange.

The secretary-bird inhabits open grass plains and steppes in Africa south of the Sahara. It spends most of its time on the ground, walking with long, stiff strides. The bird hunts lizards, small mammals, large insects, snakes, and eggs of other birds. It sprints after prey and attacks with its feet and beak.

Secretary-birds build nests on top of thorny acacia trees. The nests are made of sticks, leaves, and grass, and measure 40 to 80 inches (1 to 2 meters) across. Females lay two or three greenish or bluish eggs. The young hatch the eggs about 45 days later.

Thomas G. Balgooyen

Scientific classification. The secretary-bird belongs to the secretary-bird family, Sagittariidae. It is *Sagittarius serpentarius.*

See also Animal (picture: Animals of the grasslands); Bird (picture: Birds of Africa).

Secretary of... See the articles on the executive departments of the U.S. government listed under their key word, as in State, Department of.

Secretion. See Gland.

Section, land. See Public lands (Management).

Sectionalism. See Civil War (Causes and background of the war).

Secularism. See Political science (Secularism).

Securities. See Investment; Bond; Stock, Capital; Mutual fund.

Securities and Exchange Commission (SEC), an independent federal agency, administers and enforces federal laws governing the purchase and sale of *securities* (stocks and bonds). These laws protect people who invest money in securities. Companies with stock for public sale must disclose information on company finances as long as their securities are offered to the public.

The SEC investigates complaints and possible violations of federal securities laws. It regulates national stock exchanges. It also registers brokerage firms, investment advisers, and mutual funds, and establishes rules of conduct for them. The SEC consists of five commissioners. It was established in 1934.

Critically reviewed by the Securities and Exchange Commission

See also Investment banking; Securities Exchange Act; Stock exchange.

Securities Exchange Act is a law passed by the United States Congress in 1934 to protect people from buying unsafe *securities* (stocks and bonds). The act was part of President Franklin D. Roosevelt's New Deal program to bring the United States out of the Great Depression. Many people blamed the depression on dishonest financial practices. The Securities Exchange Act was the most important law to reform those practices.

Congress had passed the Securities Act of 1933, hoping to stop fraud within the stock market. This act requires detailed financial statements from firms issuing new securities in interstate commerce or through the mail. The Federal Trade Commission (FTC) administered the law. However, many people in government felt that the Securities Act of 1933 did not place enough federal control over the purchase and sale of securities. The 1934 act transferred enforcement of securities laws to a new agency, the Securities and Exchange Commission (SEC). The SEC regulates stock, or securities, exchanges to ensure that they function in the public interest and to prevent fraud and deception in the purchase and sale of securities. Stockbrokers and most firms that issue securities must register with the SEC. People who own more than 10 percent of a company's stock must file regular reports with the agency.

The Securities Exchange Act also gives the Board of Governors of the Federal Reserve System the authority to set *margin* requirements. Margin is the amount of money stock purchasers must deposit with brokers. Before the depression, many investors bought large amounts of stock on credit and so gave the securities market a false look of prosperity. Carol S. Greenwald

See also Securities and Exchange Commission.

Security Council. See United Nations (The Security Council).

Sedative, *SEHD uh tihv,* is a drug that decreases the activity of the central nervous system. Sedatives are prescribed mainly to ease anxiety or to produce sleep. Their effect depends on the dosage. When taken in small amounts, the drugs calm a person. Slightly larger doses cause sleep. When used to produce sleep, the drugs are generally called *hypnotics.*

Groups of drugs classified as sedatives include *barbiturates* and *peperidinediones. Benzodiazepines* and a drug called *meprobamate* also have sedative effects, but they are usually classified as antianxiety drugs. Since the early 1960's, antianxiety drugs have increasingly replaced sedatives in the treatment of anxiety (see Tranquilizer). Today, physicians prescribe sedatives mainly for insomnia and other sleep disorders.

Sedatives can be legally obtained only by prescription and should be taken only as directed. A person should not drive a motor vehicle or operate machinery after taking sedatives. Misuse of some of these drugs can lead to addiction. An overdose of sedatives can disrupt the brain's control of breathing and circulation and may be fatal. N. E. Sladek

See also Barbiturate; Bromide.

Seddon, James Alexander (1815-1880), served as the Confederacy's secretary of war during most of the American Civil War (1861-1865). He was appointed to the post in November 1862 by Confederate President Jefferson Davis. Before Seddon, four other men had served briefly in the position. Seddon held the post so long be-

cause he could work with and support Davis more than any of the four earlier secretaries could. Seddon resigned in February 1865, shortly before the war ended.

Seddon was born in Fredericksburg, Virginia. He was a member of the U.S. House of Representatives from 1845 to 1847 and from 1849 to 1851. He served in the Confederate Congress from 1861 to 1862.

Michael Perman

Sedge is one of a large family of grasslike plants that grow in wet places throughout the world. Sedges thrive in marshes, swamps, shallow water, and meadows. Like grasses, they have long, narrow leaves. But sedges usually have triangular or round, solid stems. Grasses have round, hollow stems. Sedges have three rows of leaves, but grasses have only two.

The *sheath* (covering) at the base of each sedge leaf is closed around the stem. In grasses, the side of the sheath opposite the leaf blade is split and overlaps.

Sedges have tiny green flowers on small spikes called *spikelets.* These flowers have no petals, but they have small bristles. Sedges also bear small fruits called *nutlets.* The ancient Egyptians made a writing material from a type of sedge called *papyrus* (see **Papyrus**). Today, farmers sometimes cut sedge for hay. David A. Francko

Scientific classification. Sedges make up the sedge family, Cyperaceae. The papyrus plant is *Cyperus papyrus.*

See also **Grass; Bulrush.**

Sedges, John. See **Buck, Pearl S.**

Sedimentary rock *SEHD uh MEHN tuhr ee,* is rock formed when mineral matter or remains of plants and animals settle out of water or, less commonly, out of air or ice. Sedimentary rock covers about three-fourths of the earth's land area and most of the ocean floor. In some places, such as at the mouth of the Mississippi River, sedimentary rocks are more than 40,000 feet (12,000 meters) thick. Geologists estimate that sedimentary rock has been forming for at least $3\frac{1}{2}$ billion years. Sedimentary rock is one of three major kinds of rock. The others are igneous rock and metamorphic rock (see **Igneous rock; Metamorphic rock**).

There are many types of sedimentary rock and they have a variety of uses. The most common sedimentary rock is shale. It is made of compressed *mud*—that is, a mixture of clay and *silt* (fine particles of mineral matter). Shale is used in making bricks. Limestone, another common sedimentary rock, is made chiefly of the mineral calcite. Limestone is used for building, for making chalk, and for various other purposes. Cement is made of limestone with a little shale mixed in. Sandstone, made of sand, and *conglomerate,* composed of sand or gravel particles, are also commonly used for building. The sand or gravel particles in sandstone and conglomerate are held together by a mineral cement. Coal, which consists entirely of compressed plant remains, is a major source of fuel.

Most sedimentary rock starts forming when grains of clay, silt, or sand settle in river valleys or on the bottoms of lakes and oceans. Year after year, these minerals collect and form broad, flat layers called *beds* or *strata.* The layers, which differ from one another in composition or texture, distinguish sedimentary from most igneous and metamorphic rock. After thousands of years, the beds of fine silt and clay are squeezed into compact rock layers by the weight of other layers above them. Water that trickles slowly through layers of coarse sand and gravel, deposits mineral cement around these particles, cementing the layers together to form rock. Where the earth's crust is deformed or eroded, large areas of buried sedimentary rock may be exposed.

Some sedimentary rock forms during the evaporation of water. For example, beds of rock salt were formed in bays cut off from the ocean or in saltwater lakes. As the trapped water evaporated, layers of salt crystals were left behind.

Most fossils are found in sedimentary rock. The fossils formed when sediments covered dead plants and animals. As the sediments changed to rock, either the remains or the outlines of the plants and animals were preserved. Some limestone is made entirely of fossil shells. See **Fossil.** Maria Luisa Crawford

Related articles in *World Book* include:

Chalk	Limestone	Rock (pictures; map)
Clay	Oil shale	Sandstone
Coal	Petroleum (How petroleum was formed)	Shale
Coral		Stratified rock
Flint		Travertine

Sedition, *sih DIHSH uhn,* is an act which stirs up discontent against established government authority. Many countries, including the United States, have tried at times to prevent sedition by law. Americans, however, value the right to criticize government officials and their actions. Therefore, sedition laws are unpopular in peacetime.

In time of war, statements that are likely to hinder the successful progress of the war are dealt with as sedition. Sedition is regarded as a step toward treason. But it does not aim at direct, open violence. The Espionage Acts of 1917 and 1918, enforced during World Wars I and II, provided punishment for seditious statements. It was used against enemy agents or other persons who tried to undermine the war effort. Douglas L. Wheeler

See also **Alien and Sedition Acts.**

Sedum, *SEE duhm,* is a *genus* (group) of hardy, decorative plants. Most sedums are native to the North Temperate Zone. They are *succulents*—that is, they store water in their thick, fleshy leaves (see **Succulent**). Some sedums have low, creeping stems with leaves that often grow in clusters near the ground. Landscapers often use these sedums to cover rocks and bare ground. Other sedums have tall stems and are used as border plants. Many people call sedums *live-forevers* because they do not wither easily. Sedums are sometimes called *stonecrops.* James D. Mauseth

John Kohout

Sedums

Scientific classification. Sedums are in the orpine family, Crassulaceae. They make up the genus *Sedum.*

See, Holy. See **Pope** (introduction).

Seed is the specialized part of a plant that produces a new plant. It contains an *embryo* (partly developed plant) that consists of an immature root and stem. A seed also has a supply of stored food and a protective covering.

Seeds are produced by approximately 250,000 kinds of plants. Flowering plants make up the largest group of seed-producing plants. These plants, which botanists call *angiosperms,* include the vast majority of trees, shrubs, and soft-stemmed plants. Seeds are also produced by about 800 kinds of trees and shrubs called *gymnosperms.* Most gymnosperms develop cones.

The seeds of different kinds of plants vary greatly in size. The double coconut tree produces the largest seed, which weighs up to 50 pounds (23 kilograms). On the other hand, orchid seeds are so tiny that 800,000 of them weigh no more than an ounce (28 grams). The size of a seed has no relationship to the size of the plant that develops from it. For example, the giant redwood tree grows from a seed only $\frac{1}{16}$ inch (1.6 millimeters) long.

The number of seeds produced by an individual plant varies according to the size of the seeds. A coconut tree has only a few large seeds, but an orchid or pigweed plant produces millions of tiny ones.

Kinds of seeds

Seeds develop from structures called *ovules,* which are in the flowers or on the cones of a plant. Botanists divide seeds into two main groups, *enclosed seeds* and *naked seeds.*

Enclosed seeds are produced by angiosperms. Their ovules are enclosed by an *ovary,* a structure within the flower. As the seed ripens, the ovary enlarges and forms a fruit, which provides some protection for the developing seed. In some plants, the ovaries develop into fleshy fruits, such as apples and peaches. Other plants, such as peas and poppies, have dry fruits that form pods or capsules. In grain plants, such as corn and wheat, the ovary and ovule join together, forming a hard kernel.

Naked seeds are produced by gymnosperms. The most common type of gymnosperm are the *conifers.* Conifers produce ovules on the upper surface of the scales that form their cones. Gymnosperms have no ovaries, and so their seeds are not enclosed during development. However, the scales of conifer cones close up together when the seeds are ripening and provide some protection for the seeds.

The parts of a seed

Seeds consist of three parts: (1) the embryo, (2) the food storage tissue, and (3) the seed coat.

The embryo is the part of the seed from which the mature plant develops. It contains the parts that develop into the *primary root,* the first root to grow; the stem; and the first leaves of the new plant. The embryo also has one or more specialized leaflike structures called *cotyledons.* Angiosperms have either one or two cotyledons. Those with one cotyledon are called *monocotyledons* or *monocots.* Angiosperms with two cotyledons are called *dicotyledons* or *dicots.* Gymnosperms have from two to eight cotyledons.

The cotyledons absorb and digest food from the food storage tissue of the seed. In angiosperm seeds, this tissue is called the *endosperm.* The cotyledons of some dicotyledon seeds quickly absorb all the food in the endosperm. The cotyledons then store the food that the embryo needs for growth. In gymnosperm seeds, food is stored in tissue called the *megagametophyte.*

The seed coat covers the embryo and food storage tissue and protects them from injury, insects, and loss of water. Seed coats range from thin, delicate layers of tissue to thick, tough coverings.

How seeds develop

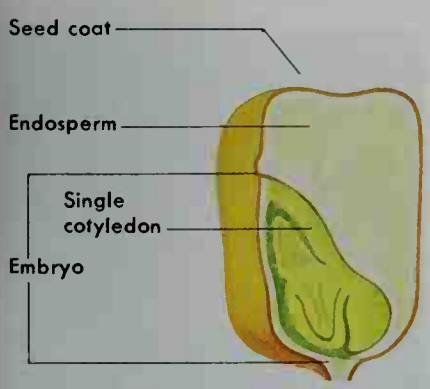
Seed formation results from sexual reproduction, in which a *sperm* (male sex cell) unites with an *egg* (female sex cell). The production of sperm and egg cells in seed plants involves a number of complicated steps. First, the male and female reproductive organs of the plant produce microscopic cells called *spores.* The spores grow into *gametophytes,* which are actually tiny plants that live within the reproductive organs of the parent plant. The gametophytes produce the sperm and egg cells.

Seed development in angiosperms. The reproductive organs of an angiosperm are in its flowers. The fe-

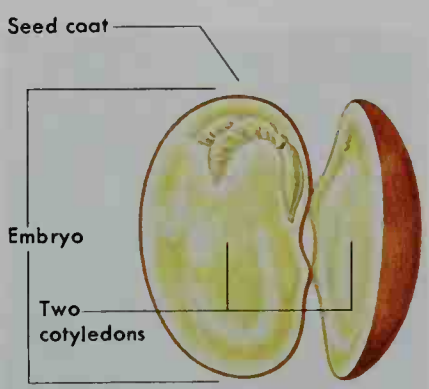
The parts of a seed

A seed consists of an embryo, food storage tissue, and a seed coat. The embryo contains the parts that form a new plant. It also has one or more *cotyledons,* which absorb and digest food from the food storage tissue. The seed coat protects the seed from injury, insects, and loss of water.

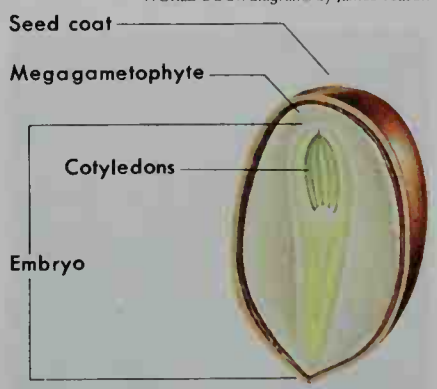
WORLD BOOK diagrams by James Teason



A monocotyledon seed, such as this corn seed, has one cotyledon. Its food storage tissue is called the *endosperm.*



A dicotyledon seed has two cotyledons. In the bean seed shown here, the cotyledons contain the food storage tissue.



A gymnosperm seed, such as this pine seed, stores food in the *megagametophyte* and has two or more cotyledons.

male reproductive organ is called the *pistil.* The ovary, which contains one or more ovules, forms the round base of the pistil. A tube called the *style* extends up from the ovary and ends in a flat tip called a *stigma.* The male reproductive organ is called the *stamen.* The stamen has an enlarged tip called the *anther.*

The development of a seed begins with cell divisions in the ovule and in the anther. These cell divisions result in the production of spores. In most plants, one spore in each ovule grows into a microscopic female plant, the megagametophyte. This tiny female plant produces one egg cell. In the anther, the spores grow into microscopic male plants called *microgametophytes,* or *pollen grains.* Each pollen grain produces two sperm cells.

For fertilization to occur, a pollen grain must be transferred from the anther to the pistil. This transfer is called *pollination.* Pollen grains are carried from the anther to the stigma by insects or other animals or by the wind. After the pollen reaches the stigma, the grain produces a long, slender *pollen tube.* This tube grows down through the style and into the ovule. The two sperm cells travel down the tube to the ovule. There, one sperm cell fertilizes the egg cell, and an embryo starts to form. The other sperm cell joins with two bodies called the *polar nuclei,* and the endosperm begins to develop. After fertilization, the outer layers of the ovule develop into the seed coat.

Seed development in gymnosperms. The reproductive organs of gymnosperms take many forms. In conifers, these organs are in cones. A conifer has two kinds of cones, *female seed cones* and *male pollen cones.* Each scale of a seed cone has two ovules on its upper surface. Cell divisions occur in the ovules, and each ovule produces a spore that grows into a megagametophyte. This tiny female plant produces egg cells. The scales of a pollen cone have structures that undergo cell divisions and produce spores. These spores develop into pollen grains.

The wind carries pollen grains from the pollen cones to the seed cones. The pollen gets stuck to a sticky substance near the ovules and begins to grow pollen tubes. Each pollen grain has two sperm cells. After the pollen reaches an ovule, one of the sperm cells fertilizes the egg cell, forming the embryo. The other sperm cell disintegrates. The megagametophyte becomes the food storage tissue of the seed. The seed coat develops from the outer layers of the ovule.

How seeds are spread

After seeds have matured, they go through a state of reduced activity called *dormancy,* when they do not sprout. During dormancy, seeds are *dispersed* (scattered) from the parent plant. Seed dispersal increases the chances that some of the seeds will fall in areas suitable for growth.

Some kinds of angiosperm seeds are dispersed while still inside the fruit. The fruit later splits apart or disintegrates and releases the seeds. In other flowering plants, the seeds are released from the fruit before dispersal.

Seeds are dispersed in various ways. In some cases, the fruit drops to the ground and the seeds sprout near the parent plant. However, most seeds have features that enable them to be carried long distances by the wind, animals, water, or people.

Many kinds of seeds are especially suited for dispersal by the wind. For example, some fruits and seeds have winglike structures that keep them aloft. They include the fruits of maple trees and the seeds of ash and elm trees. The wind also carries fruits and seeds that have fluffy coverings, such as dandelion fruits and cottonwood and willow seeds.

Animals also play an important role in seed dispersal. Birds and other animals eat brightly colored fruits. However, the seeds are not digested. They are deposited as part of the animal's body waste—sometimes many miles from the parent plant. Animals also disperse seeds by carrying fruits and seeds on their body. The fruits of the beggarstick, needlegrass, and some other plants have spines and barbs that stick to the fur of an animal. Seeds with sticky coats are also transported by sticking to an animal's body.

The seeds of most water plants are dispersed by floating on rivers, streams, and oceans. Coconut trees and some other land plants have seeds that can float. This

How seeds are spread After seeds mature, they are usually scattered far from the parent plant. Seed dispersal occurs in various ways. Some kinds of seeds have fluffy coverings, *left,* that enable them to be carried by the wind. Fruits and seeds with spines or sticky coats can stick to people's clothing, *center,* and be carried miles away. Animals disperse the seeds found within brightly colored berries, *right.* They eat the berries but do not digest the seeds, which are deposited as part of their body waste.

Derek Fell

Tom Inglesby

Ray D. Waller, Van Cleve Photography

type of seed is often transported by water.

Some kinds of seeds are dispersed by an explosive action that occurs when the fruit dries and splits apart. The splitting of a fruit can scatter seeds for several feet. The seeds of geraniums, milkweeds, and touch-me-nots are dispersed in this way.

People have brought along supplies of the seeds of various crop plants and ornamental plants when migrating to many parts of the world. People also aid seed dispersal unintentionally by carrying seeds on their shoes and other articles of clothing.

How seeds sprout

Ripe seeds sprout through a process called *germination.* After being dispersed, most seeds remain dormant instead of germinating immediately. Dormancy prevents seeds from sprouting when conditions are not favorable for growth. For example, many seeds remain dormant during the cold winter months and germinate after temperatures start to rise in spring.

Seeds can remain dormant for varying periods and still be *viable*—that is, able to germinate under proper conditions. In general, the period of viability ranges from a few weeks to 50 years. In one case, however, scientists found that dormant 10,000-year-old lotus seeds could germinate when conditions were favorable for growth.

Conditions required for seed germination include abundant water, an adequate supply of oxygen, and proper temperatures. When a seed begins to germinate, it absorbs large amounts of water. The water causes many chemical changes inside the seed. It also causes the seed's internal tissues to swell and break through the seed coat. Water also softens the seed coat so that it breaks apart more easily.

Germinating seeds require an adequate amount of oxygen to support their high rate of *respiration.* Respiration is the taking in of oxygen and the giving off of carbon dioxide. This process enables a germinating seed to burn food and thus produce energy for growth.

Temperature requirements for germination vary. Species that germinate in summer require higher temperatures than those that germinate in spring. Many seeds require a cold period before they can germinate.

Some kinds of seeds need a certain amount of daylight to germinate. Many seeds will sprout only during the spring, when the number of daylight hours increases. Others sprout only in late summer or early fall, as days shorten.

After the seed coat breaks and germination starts, the part of the embryo below the cotyledon begins to grow down into the soil. This part, called the *hypocotyl,* develops into the primary root. The developing roots anchor the seedling and absorb minerals and water that the embryo needs for further growth. The upper part of the embryo, called the *epicotyl,* has a bud called a *plumule* at its tip. The epicotyl grows longer and pushes the plumule upward above the ground. The plumule then produces the first leaves.

In the seeds of gymnosperms and certain dicots, the cotyledons are also carried above the ground. They remain on the plant until it has formed new leaves that can manufacture food. The cotyledons of monocots and some other dicots remain below the ground as the plumule emerges.

How people use seeds

Seeds serve as a major source of food for millions of people throughout the world. The seeds of cereal grains, including corn, oats, rice, and wheat, are used in making many food products, such as bread, breakfast cereals, and flour. The seeds of plants called *legumes,* which include beans, peas, and peanuts, are also important sources of nourishment.

Vegetable oils used in cooking are obtained from the seeds of such plants as corn, peanuts, soybeans, and sunflowers. In addition, manufacturers use these oils in making margarine, salad oil, and shortening. Such flavorings and spices as dill, mustard, and pepper are obtained from seeds, and seeds are used in producing beer, coffee, cocoa, and other beverages.

Seeds are also used in the manufacture of many nonfood products. Seed oils are a major ingredient in detergents, soaps, paints, and varnishes. Cornstarch from the

How seeds sprout Ripe seeds sprout through a process called *germination.* These photographs show the germination of a pine seedling. First, the lower part of the embryo breaks through the seed coat and begins to grow down into the soil, *left.* It develops into the primary root. Then the upper part of the embryo, which becomes the stem and leaves, pushes above the ground, *center.* The cotyledons spread out, *right,* and remain on the plant until new leaves form.

Walter Dawn

endosperm of the corn seed is used in making adhesives, explosives, and other products. Most livestock feed includes the seeds of corn, oats, and other grains. Some seeds, including those of the belladonna and castor-oil plants, provide substances used in medicines.

John M. Byrne

Related articles in *World Book* include:

Angiosperm	Gardening (Starting the garden)	Plant (Seeds; How plants reproduce)
Cotyledon	Germination	Pollen
Dicotyledon	Grain	Spore
Flower (The role of flowers in reproduction)	Gymnosperm	Tree (Seeds; pictures)
Fruit	Monocotyledon	
	Nut	

Seeger, Pete (1919-), is an American folk singer, musician, and composer. He first gained fame during the 1940's, singing about ordinary working people, war, and social problems. Seeger's musical style and concern with social issues influenced Joan Baez and many other folk singers. His best-known compositions include "Where Have All the Flowers Gone?" (1961).

NBC Television

Pete Seeger

Peter Seeger was born in New York City. He became interested in folk music at a folk music festival in 1935. Seeger entered Harvard University in 1936 but left in 1938 to travel around the United States, singing and painting. In 1940, he helped found the Almanac Singers, a folk group. Seeger sang with the Weavers, a folk quartet, from 1948 to the late 1950's, when he became a solo performer.

Seeger's career was harmed by a conflict with a congressional committee investigating suspected Communists in the entertainment industry. In 1955, Seeger refused to answer questions from the House Committee on Un-American Activities regarding his political beliefs and associations. That refusal led to his conviction for contempt of Congress in 1961. An appeals court overturned the conviction in 1962, but for several years Seeger was banned from network television appearances, and some organizations picketed his concerts. In time, the controversy greatly diminished. A selection of Seeger's writings on folk music was published as *The Incompleat Folksinger* (1973). Don McLeese

Seeing eye dog. See Dog guide.

Segal, *SEE guhl,* **George** (1924-2000), was an American sculptor noted for creating life-sized plaster figures in poses taken from everyday experiences. His sculptures realistically represent activities and moments normally taken for granted, such as stepping out of a shower, making a telephone call, or eating at a restaurant. He drew attention to these often-repeated daily activities by giving his works a fresh intensity through their isolation and lack of normal human association. For an example, see **United States** (The arts). Segal created granite sculptures related to the Great Depression for the Franklin Delano Ronsevelt Memorial in Washington, D.C., which opened in 1997.

Segal made his plaster casts from actual people, but the casts look anonymous and are meant to represent everyone. He usually painted the plaster white, but he also used red and blue. In most works, the figures interact with real objects, such as doors, automobile steering wheels, and chairs, which are left in their normal form. Segal was born in New York City. Deborah Leveton

Sego lily, *SEE goh,* is one of the mariposa lilies, a group of bright flowering herbs native to western North America. The sego lily is native from Washington to New Mexico. It is the state flower of Utah (see **Utah** [picture]). The flower grows on a stem about 1 $\frac{1}{2}$ feet (46 centimeters) tall. Petals from sego lilies are white, tinted with yellowish-green or lilac, and have a spot of purple at the base. The leaves of the plant are long and thin. The sego lily grows from an underground bulb. The early Mormons in Utah cooked and ate these bulbs.

Anton A. Reznicek

Scientific classification. The sego lily belongs to the lily family, Liliaceae. It is classified as *Calochortus nuttallii.*

See also Mariposa lily.

Segovia, *suh GOH vee uh,* **Andrés,** *ahn DREHS* (1893-1987), was the most influential classical guitarist of the 1900's. Segovia helped to establish the modern technique of guitar playing and was largely responsible for raising the guitar's status to that of a solo instrument in classical music. Segovia's skill encouraged important composers to write for the guitar. Segovia also adapted works of many famous composers for the guitar and wrote some original pieces. He inspired generations of guitarists through his concert and television performances, recordings, and teachings.

Segovia was born in Linares, Spain. He began to teach himself to play the guitar when he was 12 years old. By the early 1930's, Segovia had gained international fame through concert tours of Europe, South America, and the United States. Abram Loft

Girl Holding a Cat (1968); Mrs. Helen Segal Collection (Hans Namuth)

A typical George Segal sculpture is a realistic, life-sized plaster cast of a human figure in everyday surroundings.

Segregation is the separation of groups of people by custom or by law. It is often based on differences of race, religion, wealth, or culture. Many people consider such differences highly important.

Segregation can occur in almost any area of life. It is particularly evident in housing, education, and employment, and in the use of eating, sleeping, transportation, and other public facilities. Almost all systems of segregation discourage marriage between people of different racial, religious, or social groups. In the United States, for example, many states once outlawed marriage between blacks and whites. But in 1967, the Supreme Court of the United States ruled such laws unconstitutional. Segregation almost always involves some kind of discrimination by one group against another. The term *discrimination* refers to actions or practices by members of a dominant group that limit the opportunities of a less powerful group.

The term *desegregation* refers to the process of ending group separation. It generally is used to describe efforts to abolish racial segregation in the United States. The people most affected by racial segregation in the United States have been African Americans.

During the course of desegregation, two or more separated groups may begin to act toward each other in new, friendlier ways. This new relationship between the groups is called *integration*. A desegregated situation becomes integrated when people from different groups accept and become friendly toward one another.

Segregation is not limited to the United States nor to bias against racial minorities. It has been practiced in various forms in many countries throughout history.

Causes and effects of segregation

Segregation is usually the result of a long period of group conflict, with one group having more power and influence than another. The *dominant* (more powerful) group sometimes uses force, law, or custom to segregate a *subordinate* (less powerful) group. In time, segregation comes to be considered right, especially by the dominant group. Violations of the accepted code of segregation are considered wrong. People who break the code are believed to deserve stern punishment.

Further support for segregation comes from hostile attitudes and feelings between groups. The dominant group typically believes its members are born with superior intelligence, talents, and moral standards. Social scientists call these false or exaggerated beliefs *stereotypes*. The dominant group uses stereotypes to justify its mistreatment of the subordinate group. Meanwhile, the subordinate group develops fear and dislike toward the dominant group.

Segregation involves favored treatment for the dominant group. Members of the dominant group are expected to have—and usually do have—the best education, homes, jobs, and public services. As a result, their beliefs of superiority are strengthened. Most do not consider the system unfair but regard it as the proper way for society to distribute its resources. Likewise, the subordinate group may have a sense of inferiority that is reinforced by a system that denies it the social, political, and economic benefits enjoyed by others. Subordinate groups try to make up for their low position. They develop intense group loyalty and make special efforts to resist and overcome the limitations of separation.

Racial segregation in the United States

Racial segregation in its modern form started in the late 1800's. But slavery existed in the United States for more than 200 years before the American Civil War (1861-1865). After the war, former slaves suffered widespread racial discrimination, especially in the South.

Jim Crow laws, first developed in a few Northern states in the early 1800's, were adopted by many Southern states in the late 1800's. These segregation laws required that whites and blacks use separate public facilities. No detail was too small. At one time, for example, Oklahoma required that whites and blacks use separate telephone booths. Arkansas specified separate gambling tables, and many courts provided separate Bibles for swearing in witnesses. Several Southern states adopted *grandfather clauses* and other Jim Crow laws that deprived African Americans of their voting rights.

The rapid spread of segregation laws through the South was supported by a series of Supreme Court decisions. The most influential case was *Plessy v. Ferguson* in 1896. In that case, the court supported the constitutionality of a Louisiana law requiring separate but equal facilities for whites and blacks in railroad cars. *De jure* (by law) racial segregation was strengthened by this decision. For more than 50 years, many states used the "separate but equal" rule to segregate African Americans in public schools and in transportation, recreation, sleeping, and eating facilities.

The beginning of change. The system of de jure segregation gradually began to crumble in the 1900's. During World War I (1914-1918), orders for military equipment created a great demand for labor. The demand led to mass black migration from the South to the manufacturing centers of the North. In 1910, about a tenth of all black Americans lived outside the South. Today, more than half live outside the South.

Partly as a result of this migration, African Americans, starting in the 1930's, gained increasing prominence in national politics and a fairer hearing in federal courts. One high point was reached in the 1954 case of *Brown v. Board of Education of Topeka,* in which the Supreme Court ruled against de jure segregation in public schools. The court held that "in the field of public education the doctrine of 'separate but equal' has no place. Separate educational facilities are inherently unequal." In 1969, the court ordered public school districts to desegregate "at once."

Beginning in 1973, the Supreme Court ordered school desegregation in certain Northern cities, where school boards had drawn school district lines that contributed to segregation. The Supreme Court often ordered the busing of pupils to ensure that most schools in a district would have a similar proportion of minority group students. Many white people throughout the country opposed busing and other desegregation efforts. As a result, judges and policymakers began to issue fewer and fewer orders calling for school desegregation.

By the end of the 1900's, segregation had again increased in public schools. Large numbers of white residents had moved from central cities to suburbs to escape desegregation. This migration, sometimes called

white flight, and growth in the number of private schools left public schools in many large cities with mostly minority students.

De facto segregation. In the 1960's, national attention shifted to *de facto* segregation—that is, segregation in fact. This type of separation has developed more by custom than by law. Although many laws supporting de jure segregation were declared unconstitutional, de facto racial segregation increased during the mid-1900's.

In cities, African Americans were almost as segregated in housing at the end of the 1900's as they were at the beginning of the century. Such segregation remained one of the most serious problems facing people of color. Many blacks suffered from a practice called *steering,* in which real-estate agents showed them housing only in areas that already had many black residents. Laws prohibit such practices, but many victims find it hard and expensive to get compensation from courts.

Efforts to eliminate segregation have to some degree benefited middle-class African Americans. This group, which accounts for about a fourth of all black Americans, has the education and the skills to take advantage of new opportunities even though they still face discrimination. But the economic and political situation has not basically improved for millions of unskilled, low-income African Americans. In some ways, the poor are worse off than they were in the 1950's.

De facto segregation and racial discrimination have been basic causes of racial riots in American cities since the 1960's. The riots have represented, among other things, a mixture of desperation and defiance.

Antidiscrimination laws are a major tool for breaking down de facto segregation. For example, the Civil Rights Act of 1964 provides protection against discrimination in employment and education. However, many such laws have inadequate means of enforcement. By the end of the 1990's, many African American communities turned their efforts toward creating effective, supportive, separate schools for black children. The curriculum in such schools emphasized African art, music, and culture; the achievements of black African civilizations; and African American history. There were also attempts to create more black-owned businesses and self-help organizations. As a group, these educational and social movements were known as *Afrocentrism.*

Other segregation in the United States

Other minorities besides African Americans have been victims of segregation and discrimination in the United States. In the 1800's, for example, white settlers took much land from American Indians and forced them to move to reservations. Since then, most Indians have suffered political and economic discrimination.

During the late 1800's and early 1900's, Congress passed laws to stop immigration from Asia. During World War II, after Japan attacked a United States naval base in 1941, thousands of loyal Japanese Americans lost many of their constitutional rights and were imprisoned in detention camps. Immigrants from Mexico, Puerto Rico, and southern and eastern Europe also have suffered discrimination.

Segregation of other minorities has generally been less forceful and less obvious. Many Jewish Americans, for example, have been excluded from certain residential areas. Many have also been discriminated against in educational and job opportunities by quotas that limited Jewish participation in colleges and other institutions. These practices have steadily declined since the 1930's, but Jewish Americans still face subtle forms of discrimination. Such discrimination occurs in some social clubs, in political nominations, in promotions to the top positions in large corporations, and in other areas.

Sometimes segregation is voluntary rather than forced. For this reason, sociologists distinguish between a segregated ghetto and an ethnic area of choice. A ghetto is, in effect, a prison, because forced segregation gives its people little choice of living elsewhere. An ethnic area of choice is a community where members of a group prefer to live, though they could live elsewhere. For example, many U.S. cities have communities of such groups as Italian Americans and Polish Americans.

Segregation in other countries

Segregation has existed for many centuries. In the Middle Ages, from about the 400's to the 1500's, segregation was especially directed against European Jews. In many countries, Jews had to live in city ghettos. Laws prohibited them from owning land, joining labor guilds, or practicing medicine or law. As a result, many Jews could earn a living only in occupations avoided by Christians, including moneylending and tax collecting.

Segregation also can occur along religious lines, with sacred approval. An example is the complex Hindu system of separation by *castes* (social categories created by ancient religious laws) in India. For about 2,000 years, the many castes remained strictly separated in almost all areas of life. In 1948, the Indian government began a campaign against the caste system. Progress has been made, but strong segregation continues to occur.

In most countries, segregation and discrimination are based on national and racial differences. For example, Koreans living in Japan are typically segregated, discriminated against, and regarded as inferiors by the Japanese. In 1948, the government of South Africa adopted a policy of rigid racial segregation called *apartheid.* This policy aimed to subordinate black Africans in every walk of life. In 1991, the government repealed the last of the laws that formed the legal basis of apartheid, and in 1994 the country's white leaders handed over power to a new multiracial government. But some de facto racial segregation remains in South Africa.

By the end of the 1900's, racial and ethnic segregation had declined in some parts of the world. Several forces led to increased contact across class, cultural, racial, religious, and national lines. These forces included the end of colonialism, the expansion of literacy, the rapid growth of cities, and protest movements by subordinated peoples. Other forces encouraging integration were mass migrations and the growth of transportation systems and of mass communication. Joe R. Feagin

Related articles in *World Book* include:

African Americans
Apartheid
Asian Americans
Brown v. Board of Education of Topeka
Caste
Civil rights
Grandfather clause
Hispanic Americans
Indian, American
Jews
Jim Crow
Minority group
Oriental exclusion acts
Plessy v. Ferguson
Racism

Additional resources

Meyer, Stephen G. *As Long as They Don't Move Next Door: Segregation and Racial Conflict in American Neighborhoods.* Rowman & Littlefield, 2000.

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Sei whale, *say,* is a large, slender whale that lives in all the oceans. Sei whales are most commonly found in deep temperate waters. The whales migrate to colder waters to feed in summer and to warmer waters to breed in winter.

North of the equator, male sei whales reach 55 feet (17 meters) in length, and females reach 62 feet (19 meters). Both sexes are slightly larger in the Southern Hemisphere. Sei whales are mostly dark gray with a lighter gray belly. They have a prominent dolphinlike *dorsal fin* on the rear half of the back.

Sei whales feed on fish, squid, and krill or other tiny shellfish. The whale lunges into large masses of prey, opening its mouth toward the end of the lunge. As the whale feeds, numerous pleats of skin lining the whale's throat expand, permitting the whale to take in huge volumes of water and prey. The whale then expels the water, filtering the food through coarse plates called *baleen* that hang from its upper jaw.

Commercial whalers hunted sei whales extensively during the 1960's and 1970's, greatly reducing the numbers of these whales worldwide. International restrictions now protect sei whales. Bernd Würsig

Scientific classification. The sei whale belongs to the family Balaenopteridae in the suborder Mysticeti, order Cetacea. Its scientific name is *Balaenoptera borealis.*

See also **Whale** (picture: Some kinds of whales).

Seiche, *saysh,* is a long wave motion in a lake, a bay, or a similarly enclosed body of water. The usual cause of a seiche is a wind that blows over the surface of the water. Other causes include earthquakes and changes in atmospheric pressure.

Wind can start a seiche in a lake by piling up the water on one side of the lake—the left side, for example. If the wind suddenly dies down, this water will start to move toward the right side of the lake. Thus, the water level will begin to fall on the left side and—at the same time—begin to rise on the right side. As the water reaches its highest level on the right side, it will reverse direction, moving toward the left side. The water level will then fall on the right side and rise on the left.

The flow of water will reverse again and again. However, the friction of the water against the bottom of the lake will cause the flow to die down gradually and then to stop. Philip L-F. Liu

Seigneurial system, *seen YUR ee uhl,* also spelled *seigniorial,* was the traditional method of landholding in France. It came into use in colonies that France established in eastern Canada during the early 1600's and lasted about 250 years. The system did much to strengthen the growth of French culture in Canada.

The king of France granted large areas of land in Canada to nobles, religious groups, military officers, and merchants. The grants, called *seigneuries,* generally covered from 12 to 100 square miles (31 to 260 square kilometers). Many of them bordered the St. Lawrence River and extended inland in narrow strips. The owners, called *seigneurs,* rented sections of their land to farmers. Each year, the farmers, known as *habitants* or *censitaires,* gave the seigneurs a share of the harvest, a fee, and several days work without pay. Habitants and seigneurs in turn owed the king military service and helped build public roads.

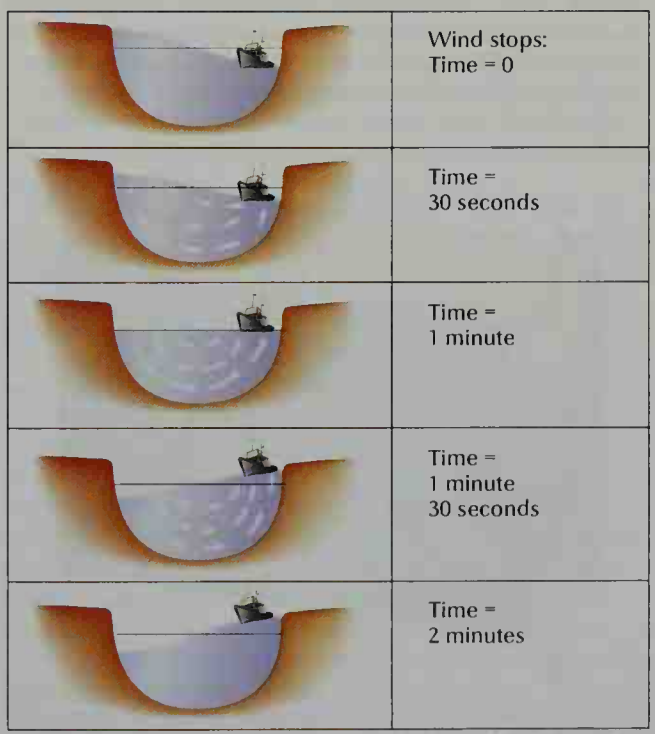
The number of habitants in Canada increased during the 1700's, and the seigneurs earned large profits. But many of the holdings limited urban and industrial growth during the early 1800's. The Canadian government abolished the seigneurial system in 1854.

Cornelius J. Jaenen

Seine River, *sayn,* and its branches form the chief commercial waterway of France. It rises on the Langres Plateau 18 miles (29 kilometers) northwest of Dijon. From there, the Seine flows in a winding course about 480 miles (770 kilometers) northwest to its mouth in the English Channel near Le Havre. About 235 miles (378 kilometers) from its source, it becomes the broad river that flows through the heart of Paris. For the location of the Seine, see **France** (terrain map).

In Paris, the Seine moves under more than 30 bridges. On the Left Bank—the section of the city south of the Seine—are such landmarks as the Latin Quarter, the Sorbonne, the Luxembourg Gardens, and the Eiffel Tower. On the Right Bank, to the north, are the Louvre, the Champs Élysées, and the Trocadero. The Cathedral of Notre Dame stands on the *Île de la Cité* (Island of the City) in the Seine.

Boats on the Seine carry sightseers through Paris. Boats also carry people and goods westward from Paris on the Seine past St.-Cloud, famous for its horse races, and past St.-Germain with its handsome palaces. The



WORLD BOOK diagrams by Paul Perrault

A seiche begins when wind piles up water on one side of a lake and then stops blowing. The piled-up water drops, creating a wave. The water will flow back and forth until the friction of the water against the lake bottom overcomes the force of the wave.

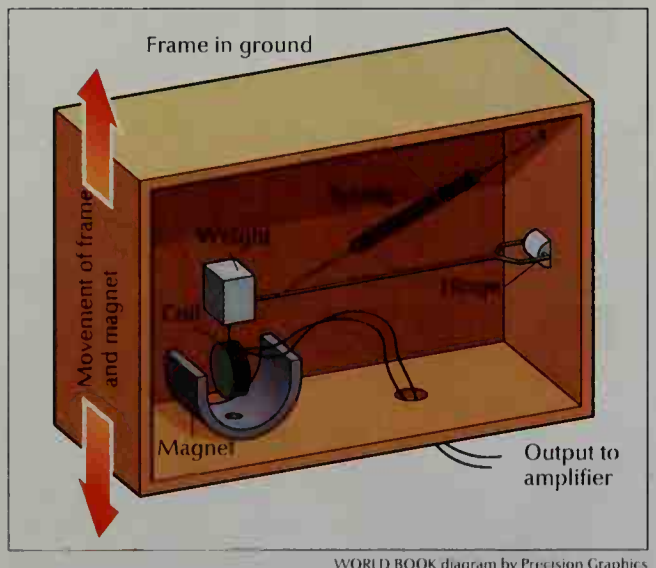
Seine then winds through the province of Normandy to Rouen and the seaport of Le Havre. Southeast of Paris, the river flows near Fontainebleau.

The Seine is important to commerce. It is joined by the Aube, Marne, Yonne, and Oise rivers. Canals connect the Seine with the Loire, Rhône, Rhine, Meuse, and Schelde rivers. Boats can sail about 340 miles (547 kilometers) of its length. The Seine has flooded its banks many times. It caused extensive damage to crops and property when it rose more than 24 feet (7 meters) during a flood in 1910. Hugh D. Clout

Seismograph, *SYZ muh graf,* is an instrument that records tiny movements of the ground. Some seismographs can detect ground motion as small as one-tenth of a nanometer. A nanometer equals one-billionth of a meter, or $\frac{1}{25,400,000}$ inch. Scientists known as *seismologists* use seismographs for studying the earth's interior, determining the location and intensity of earthquakes, and hunting for oil. Scientists have even used seismographs placed on the moon by astronauts. Those devices recorded moonquakes and meteorite impacts.

A seismograph detects ground movement by means of a weight that is suspended from a frame by a delicate spring. The frame moves with the ground. But the weight, due to its inertia, tends to remain stationary.

The seismograph records the movement electronically. First, a device called an *electromagnetic transducer* converts the movement to an electric signal. The main parts of the transducer are a coil of wire, which is attached to the weight; and a magnet, which is attached to the frame. Like any other magnet, the transducer magnet creates a *magnetic field,* an influence in the region around it. When the ground moves, the field moves relative to the coil. Through a process called *electromagnetic induction,* the changing field creates a voltage in the coil. Next, an amplifier strengthens the voltage. An *analog-to-digital converter* then translates the voltage to numbers. Finally, the converter sends the numbers to a computer, which records them.



WORLD BOOK diagram by Precision Graphics

A seismograph detects movement that makes its frame and an attached magnet move up and down. A weight and a wire coil suspended by a spring do not move. As a result, the magnet creates a voltage in the coil that represents the movement. An amplifier and other devices strengthen and record the voltage.

A clock simultaneously records the time. Time signals broadcast by satellites of the Global Positioning System (GPS) keep this clock extremely accurate. The GPS is a worldwide navigation system that uses time and position signals broadcast by satellites.

Scientists prefer to install seismographs away from sources of unwanted vibration. Those sources include human activities, such as automobile traffic, and natural phenomena, such as the wind. The most sensitive installations are in *seismic vaults,* chambers dug several yards or meters below the ground. Some seismographs are installed in *boreholes,* narrow holes more than 330 feet (100 meters) under the ground.

Detecting earthquakes. Earthquakes produce waves of vibration that differ in *wavelength* (distance between wave crests). In the past, seismologists used different seismographs to detect short and long waves. Those devices were designed to detect waves whose wavelength fell within a certain band or range. Seismologists used those instruments to avoid recording unwanted vibrations created when ocean waves break on the shore. A modern seismograph is a *broadband* device; it can detect both short and long seismic waves. The computer filters out the unwanted information from the data that it records.

Earthquake waves also vary in strength. Some are so strong that sensitive broadband seismographs cannot measure them. To measure such waves, scientists use devices called *strong-motion accelerographs.*

Scientists use seismographs in groups of three to measure the ground motion in three directions: up-and-down, north-and-south, and east-and-west. Thus, a complete seismic observatory has three broadband seismic sensors, three strong-motion sensors, an analog-to-digital converter, a GPS clock, and a recording computer.

Searching for oil. Seismographs used for oil prospecting are tiny and rugged. Scientists place hundreds of them around the site being studied, then set off explosives to create seismic waves. The waves reflect from underground rock layers, and the seismographs measure the reflected waves. The measurements indicate what lies beneath the surface. Barbara Romanowicz

Related articles in *World Book* include:
Earthquake (Recording, measuring, and locating earthquakes)
Global Positioning System
Inertia
Moment magnitude
Petroleum (Geophysical studies)
Richter magnitude
Seismology

Seismology, *syz MAHL uh jee,* is the study of *seismic waves* (shock waves) produced by earthquakes or explosions. Scientists called *seismologists* study these waves to learn about earthquakes and about the structure of the earth. Seismology forms a branch of *geophysics,* the science that applies physics to the study of the earth and its atmosphere.

Instruments called *seismographs* detect and record the movement of seismic waves (see **Seismograph**). Seismologists use these records to determine the location and strength of earthquakes. Scientists also use seismographs in exploring for minerals and petroleum. Charlotte E. Keen

See also **Moment magnitude; Richter magnitude.**

Selassie, Haile. See Haile Selassie I.

Selective Service System (SSS) is an independent agency of the United States government whose purpose is to provide drafted men to the armed forces in an emergency. The agency also runs an alternative service program for men classified as conscientious objectors (see **Conscientious objector**). Virtually all men of ages 18 through 25 are required by law to register with the Selective Service System.

In the event of an emergency requiring an increased military force, the SSS would conduct a draft using a list of names of registered men. Potential draftees would be evaluated at a military entrance processing station and classified based on the evaluation. Men classified 1-A would be available for induction. But they could file a claim with their local board for exemptions, deferments, and postponements from military service. The board would decide the outcome of each registrant's case. A registrant could appeal the decision.

The SSS was established in 1940 to administer the draft needed during World War II (1939-1945). In 1973, the U.S. government ended the draft and began accepting only volunteers into the armed forces. In 1980, Congress passed legislation resuming the registration requirement for the draft. Robert R. Mackey

See also **Draft, Military.**

Selene, *sih LEE nee,* was the principal goddess of the moon in Greek mythology. The Roman goddess Luna resembled her. Helios, the sun, was Selene's brother. Every day, he drove his fiery chariot across the sky. After his return, Selene drove her own chariot across the sky. The rays from her golden crown lit up the night.

Selene played an important part in ancient magic rituals, but she appears in few myths. The best-known story about Selene tells of her love for Endymion, a handsome mortal. Either Selene or Zeus, the king of the gods, caused Endymion to fall into an eternal sleep.

Most ancient sources say that Selene's parents were Titans named Hyperion and Theia. Other sources say her parents were Zeus and his mistress Leto. Many ancient Greek writers confused Selene with the goddess Artemis. As a result, some myths incorrectly identify Artemis as the goddess of the moon. C. Scott Littleton

See also **Artemis; Endymion; Luna; Titans.**

Selenium, *sih LEE nee uhm,* is a semimetallic chemical element. In nature, it most often occurs in combination with such metals as copper, lead, and silver. The Swedish chemist Jöns J. Berzelius first isolated selenium in 1817. Human beings and other animals require tiny amounts of selenium in their diet. The element helps the body convert fats and protein into energy. Foods that supply selenium include meat and fish.

Selenium exists in several forms called *allotropes.* The most stable allotrope is gray selenium, a solid that forms when the element is heated to 180 °C and cooled. Gray selenium is a semiconductor and becomes a better conductor of electricity when exposed to light and heat. It is used to make electric eyes, solar batteries, and photographic exposure meters. It also is used in electrostatic copying machines.

Selenium has the symbol Se. Its atomic number is 34, and its atomic weight is 78.96. Gray selenium melts at 217 °C and boils at 685 °C. Marianna A. Busch

Seles, *SEHL uhs,* **Monica** (1973-), became the number-one ranked woman tennis player in the world in 1991 at the age of 17. She was the youngest player, man or woman, to achieve a number-one ranking. In 1991 and 1992, Seles won three of the four grand slam tennis championships—the Australian Open, French Open, and United States Open. She reached the final of the fourth championship, Wimbledon, in 1992 and did not play in that tournament in 1991. Seles also won the French Open in 1990 and the Australian Open in 1993 and 1996. Seles, a left-hander, is known for her powerful two-handed backhand and forehand.

Seles, an ethnic Hungarian, was born in Novi Sad, Yugoslavia. She moved to Florida in 1986 and turned professional in 1989. Seles was stabbed by a spectator during a tournament in Germany in April 1993, forcing her to drop out of competition. She resumed her playing career in August 1995, winning the Canadian Open. She became a U.S. citizen in 1994. Donna K. Doherty

Seleucid dynasty, *suh LOO sihd,* refers to a series of kings who ruled in southwest Asia from 312 to 64 B.C. Seleucus I, a Macedonian general, had served under the Macedonian conqueror Alexander the Great. By 323 B.C., when Alexander died, he controlled much of southwest Asia. Seleucus established an empire from part of this area. At its height, the Seleucid Empire extended from Asia Minor (now Turkey) eastward to India. The Seleucids established many cities and promoted the spread of Greek customs and religious beliefs.

During the 200's B.C., the Parthians took over the far eastern region of the empire. In 188 B.C., the Romans forced the Seleucid king Antiochus III to give up much of Asia Minor. Later during the 100's B.C., the Seleucids lost control of Palestine to the Jews and Mesopotamia to the Parthians. Syria, the last Seleucid territory, fell to the Romans in 64 B.C. Jack Martin Balcer

See also **Judah Maccabee; Syria** (History).

Seljuks, *sehl JOOKS,* were members of a ruling family of Turkic-speaking peoples who controlled much of southwestern Asia from the mid-1000's to the mid-1200's. They originated in an area of central Asia called Turkestan and were named for Seljuk, their first leader. The Seljuks also became one of the first Turkish peoples to rule in Asia Minor (now Turkey).

In 1055, Seljuk forces conquered part of the Arab Empire in southwestern Asia. In 1071, Seljuk armies defeated Byzantine forces in the Battle of Manzikert. This victory enabled them to eventually win control of Asia Minor. By the end of the 1000's, the Seljuks had gained control of Persia (now Iran), Syria, and Palestine. Like most of the people in these areas, the Seljuks were *Muslims* (followers of Islam).

The Seljuks defended Islamic civilization during the *Crusades.* The Crusades, which began in 1096, were a series of military expeditions led by European Christians who wanted to drive the Turks out of Palestine (see **Crusades**). Much of the Seljuk Empire declined during the 1100's. But the Seljuk branch in Asia Minor flourished until the 1240's, when Mongol invaders weakened its rule. This branch laid a foundation for the rise of the Ottoman Empire in the 1300's. Andrew C. Hess

See also **Muslims** (The Seljuk Turks); **Palestine** (Arab control); **Turkey** (The Seljuk Turks).

Selkirk, Earl of (1771-1820), was a Scottish colonizer who opened the Canadian West for settlement during the early 1800's. He founded the Red River Colony, the

first permanent settlement in what is now Manitoba (see Manitoba [The Red River Colony]).

Selkirk, whose given and family name was Thomas Douglas, was born on June 20, 1771, on St. Mary's Isle in Kirkcudbrightshire (now Dumfries and Galloway Region), Scotland. He became the fifth Earl of Selkirk in 1799. In 1803 and 1804, Selkirk sent about 900 Scottish peasants to settle in the Canadian colonies of Prince Edward Island and Upper Canada. He established the Red River Colony in 1812 with about 100 people. But the farming colony interfered with the local fur trade. In 1815, trappers of the North West Company, a fur-trading firm, and a group of *métis* (people of mixed white and Indian ancestry) drove out the settlers. Troops led by Selkirk regained control of the colony in 1817.

J. M. Bumsted

Selkirk Mountains, a range in southeastern British Columbia, extend north from the United States boundary to the Columbia River. The Columbia River and its tributary, the Kootenay, run almost completely around this range. The largest of the many glaciers in the Selkirk Mountains is the Illecillewaet, near the Glacier House station of the Canadian Pacific Railway line. Mount Sir Sandford (11,590 feet, or 3,533 meters) is the highest peak in the Selkirks.

The range is about 200 miles (320 kilometers) long, and about 80 miles (130 kilometers) wide. Gold was discovered there in 1857, and silver, copper, zinc, mercury, coal, and marble also have been found. The mountains were named for Thomas Douglas, Earl of Selkirk.

Graeme Wynn

Selling. See Sales.

Selsam, Millicent Ellis (1912-1996), was an American author of introductory science books for children. She wrote about scientific subjects in a clear, interesting manner that children can understand easily. Selsam often challenged her readers by asking them questions meant to arouse their curiosity and interest in a subject. Her books won praise for their ability to increase a child's desire to learn more about a topic.

Selsam wrote about 130 books for children, beginning with *Egg to Chick* (1946). Her works include *Hidden Animals* (1947), *All Kinds of Babies and How They Grow* (1953), *Birth of an Island* (1959), *Questions and Answers About Ants* (1967), *How Puppies Grow* (1971), *Popcorn* (1976), and *Don't Throw It, Grow It* (1977). She was born on May 30, 1912, in New York City. Marilyn Fain Apseloff

Selva. See Rain forest.

Selye, *SEH lyay,* **Hans** (1907-1982), was a Canadian scientist who became known for his concept of strains on the body known as *stress.* His study of endocrine glands helped him develop new understandings of the nature and effects of disease and the body's reactions to problems or events in a person's life. His medical research showed what can be done to adjust the body to many types of unpleasant situations.

Selye was born on Jan. 26, 1907, in Vienna, Austria. He received M.D. and Ph.D. degrees from the German University of Prague. Selye spent most of his professional career at the University of Montreal in Canada. In 1945, he became director of the university's Institute of Experimental Medicine and Surgery. After retiring in 1976, Selye founded the International Institute of Stress at the university. Dale C. Smith

Semantics is the name for the scientific study of the meaning of words and sentences. Semantics is closely associated with the disciplines of linguistics, logic, and philosophy.

One aspect of word meaning involves the ways words can be semantically related to other words. Examples of semantic relations include *synonymy,* or sameness (big-large); *antonymy,* or opposites (big-little); *hyponymy,* or subclass (rose-flower); and *part-whole* (handle-cup). Another aspect of word meaning is *polysemy,* the property of having many meanings. *Foot* and *head,* for example, are words with multiple meanings. The meanings of words change over time. *Historical semantics* is the study of these changes. For example, *deer* once referred to animals in general, and *starve* once meant *die. Etymology* is the study of the origin and development of words.

The meanings of sentences result from word meaning and *syntax*—the way words are put together. In *Cats chase dogs* and *Dogs chase cats,* both sentences have the same words and the same structure. But in the first example, we understand that cats are chasing dogs, while in the second we understand that dogs are chasing cats. Formal semantics, which comes from philosophy, is concerned with *truth conditions*—the view that to know the meaning of a sentence is to know all situations and conditions under which it is true.

Entailments and *presuppositions* are another part of sentence meaning. Entailments are relations that connect statements. Whenever statement A is true, statement B is true. *John killed the deer* entails, or requires, that the deer is dead, while *John shot the deer* does not. Presuppositions are statements that are assumed to be true. *John realizes that it is raining* presupposes that it is raining. *Mary regretted that her brother caused a lot of trouble* presupposes that Mary has a brother and that he caused a lot of trouble.

Meanings are sometimes "packed" into words. For example, English divides the color spectrum into 11 basic color words. But Dani, a language of New Guinea, has only two color words which, roughly translated, mean *dark* and *light. Comparative lexicology* examines the vocabularies of different languages to learn how meanings are packed into words. Adrienne Lehrer

See also **Dictionary; Linguistics** (The components of a grammar).

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Semaphore, *SEHM uh fawr,* is a method of signaling with targets or flags. Each flag position has a meaning that people trained in semaphore signaling can interpret. Switch mechanisms of railroad signals have semaphore targets that indicate how switches are set. The United States Navy uses semaphore flags for short-range signaling. Messages are sent by two flags, each of which has two colors. Boy Scouts once learned how to send messages with semaphore flags. Carol E. Stokes

See also **Flag** (picture: Semaphore flags); **Railroad** (Traffic control).

Semicolon. See Punctuation.

Semiconductor is a material that conducts electric current better than an insulator like glass, but not as well as a conductor like copper. A computer chip is a piece of a semiconductor, usually silicon, that contains an electronic circuit. Solar cells that convert light energy to electric energy are made of semiconductors, as are some lasers. Silicon (Si) is the most widely used semiconductor. Other major semiconductors include germanium (Ge) and gallium arsenide (GaAs).

Semiconductor crystals. Unlike an insulator, a semiconductor will conduct a small electric current at room temperature. And unlike a metal, a semiconductor will conduct more current as its temperature is increased. These characteristics are a result of the semiconductor's atomic and crystal structure.

For example, a normal silicon atom has a nucleus made up of 14 protons and 14 neutrons. Surrounding the nucleus are 14 electrons. The atom is electrically neutral: The neutrons have no net electric charge, and the positive charge of the 14 protons balances the negative charge of the 14 electrons.

The electrons are arranged in three *shells* that can be thought of as different-sized spheres with the nucleus in the center. The innermost shell has two electrons, the middle shell has eight, and the outermost shell has four.

The outermost four electrons are responsible for holding the crystal together. Each atom is *bonded* (joined) to four others, except for the atoms on the crystal's surface. Each bond consists of a pair of electrons—one from the outermost shell of each of two atoms.

Electrons always vibrate, and the amount of the vibration depends on temperature—the higher the temperature, the greater the vibration. At room temperature, some of the outermost electrons vibrate so much that they leave their bonds. They become *free electrons*—electrons that can move about in or on the crystal.

Current is a flow of charge. If a battery is connected to the crystal, free electrons will flow as current. Because the number of free electrons depends on temperature, the amount of current will also depend on temperature.

Doped crystals. Semiconductor devices use crystals containing tiny amounts of *dopants*—atoms of other substances. A crystal can be *n-doped* or *p-doped*.

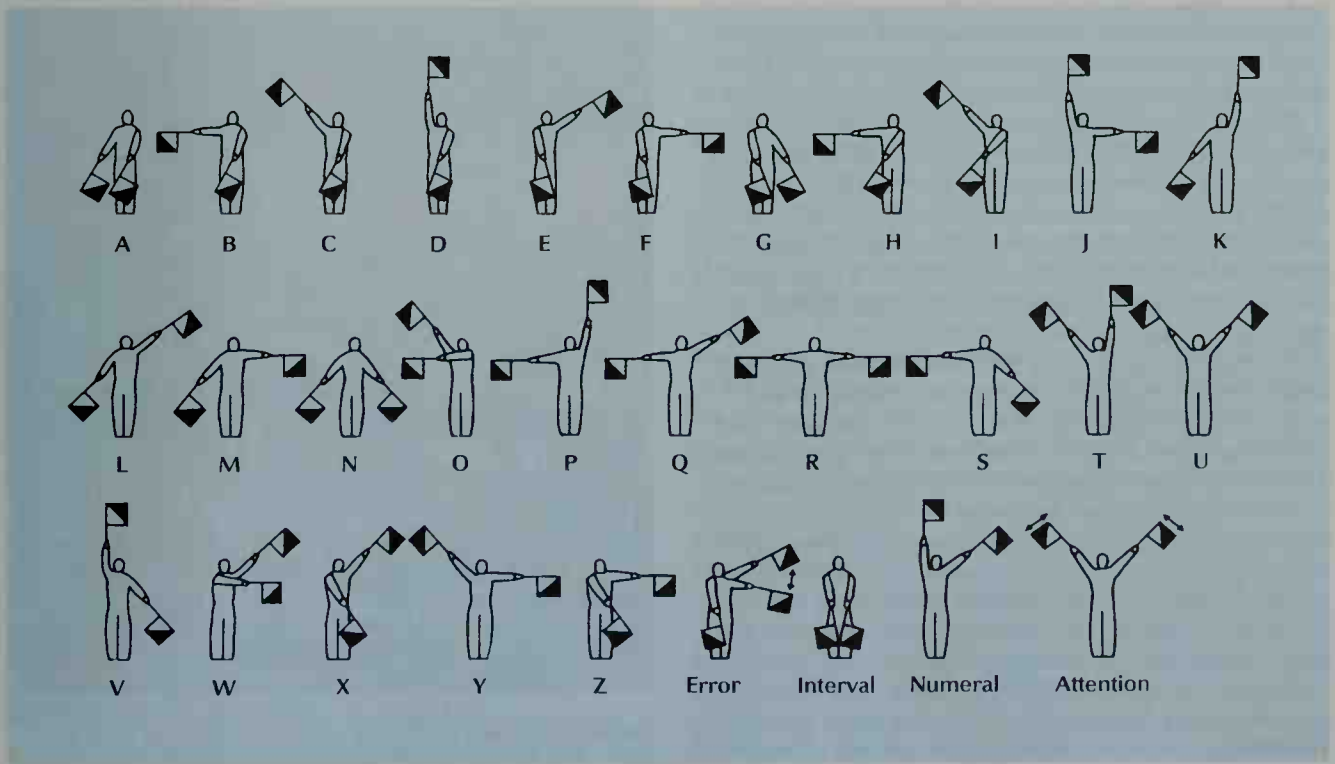
N-doped crystals usually use phosphorus as the dopant. A normal phosphorus atom has 15 protons, 16 neutrons, and 15 electrons. Five of the electrons are in the outermost shell. Only four of them are needed for bonding with the four surrounding silicon atoms. As a result, the fifth one can easily become a free electron—an extra charge carrier. N-doped crystals get their name from the *n*egative charge of their extra charge carriers.

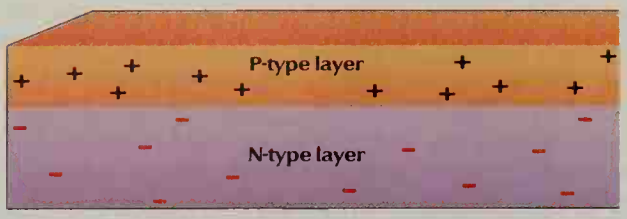
P-doped crystals usually use boron dopant. A normal boron atom has five protons, six neutrons, and five electrons. Three of the electrons are in the atom's outermost shell. Each of these electrons is in a bond with a surrounding silicon atom. As a result, the fourth silicon atom has an unpaired electron in its outermost shell. That is, there is a hole in the crystal.

A nearby bonding electron can easily gain enough energy to leave its bond and move into the hole. The electron leaves behind a hole that can be occupied by yet another electron. This process can continue as long as the crystal is warm enough. For convenience, designers of electronic devices refer to the process as a flow of holes, rather than a succession of movements of individual electrons. Because electrons are negatively charged,

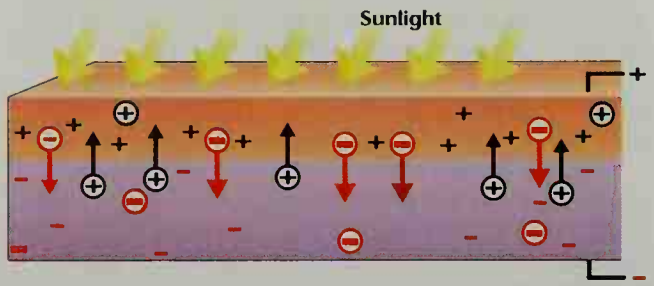
The semaphore code makes use of two flags for sending messages. Flag positions represent letters and special words. To transmit a number, the sender makes the *numeral* sign, spells out each digit in the number, and again signals *numeral*.

WORLD BOOK illustration by David A. Cunningham





A solar cell consists of two layers of doped silicon, *above.* Near their boundary, the p-type layer is negatively charged, so negative electrons (−) cannot enter it. The n-type layer is positively charged near the boundary, so positive holes (+) cannot enter it. Sunlight frees additional charges, *below, in circles,* some of which cross the boundary and leave the cell as electric current.



WORLD BOOK diagrams by Mark Swindle

the holes are positive. P-doped crystals get their name from this *p*ositive charge.

Using doped crystals. A solar cell is one of the simplest electronic devices. It consists of an n-type layer of silicon next to a p-type layer of silicon. The boundary between the layers is known as the *junction.*

When the cell is produced, electrons cross the junction. They leave the n-type layer near the junction and fill holes in the p-type layer near the junction. A boron atom that gains an electron in this way becomes negatively charged—it has six electrons but only five protons. Thus, the movement of electrons creates a negatively charged region next to the junction in the p-type layer.

In addition, holes leave the p-type layer near the junction and replace electrons in the n-type layer. Phosphorus atoms that gain a hole become positively charged. Thus, the movement of holes creates a positively charged region next to the junction in the n-type layer.

Because negatively charged objects repel each other, it eventually becomes much more difficult for any more electrons to flow from the n-type layer to the p-type layer. And because positively charged objects repel each other, it becomes much more difficult for any more holes to flow from the p-type layer to the n-type layer. As a result, a balanced condition occurs, with regions of opposite charge near the junction.

However, because of the attraction between oppositely charged objects, free electrons created in the p-type side of the junction flow to the n-type layer, and free holes created in the n-type side of the junction flow to the p-type layer. Sunlight striking the cell creates free electron-and-hole pairs by giving up its energy to them. Electrons build up in the n-type layer, and holes, in the p-type layer. If a wire is connected to both layers opposite the junction, current will flow through the wire. The current will consist of the separated free electrons and holes returning to their original layers. Peter Bohdan Kosel

See also **Computer chip; Electronics** (Solid-state components); **Laser** (Semiconductor lasers); **Solar energy; Transistor.**

Seminary, *SEHM uh* NEHR *ee,* is a school for training future clergy and lay leaders for churches or other religious organizations. It may also be called a *theological school* or a *divinity school* and is commonly a graduate-level institution.

In North America, many religions have seminaries. Seminary students generally study doctrine, history, philosophy, and sacred writings of their religion. Many also study such subjects as pastoral psychology, religious education, worship, and preaching. Most North American seminaries offer master's and doctor's degrees. Some religious groups award diplomas, licenses, or certificates instead of degrees. The Association of Theological Schools, the major accrediting body for seminaries, has over 200 member institutions. Kenneth O. Gangel

Seminole Indians, *SEHM uh nohl,* fought to keep their lands in Florida during the 1800's. They opposed United States government troops and local militia sent to force them west to Indian Territory (now Oklahoma).

Some Seminole spoke the Muskogee language. They originally belonged to the Creek confederation of tribes, and lived in what are now Alabama and Georgia (see **Creek Indians**). During the 1700's, they moved into Florida, then occupied by the Spanish. The Indians shared the area with another group of Indians, who spoke the Mikasuki language. Together the two groups became known as *Seminole,* meaning *runaways.* The British took Florida in 1763 and often incited the Seminole against American settlers. Black slaves who escaped from their masters sometimes found safety with the Seminole. For these reasons, Americans fought against the Seminole in the First Seminole War (1817-1818), which took place in southern Georgia and in Florida. In 1818, forces under Andrew Jackson quickly defeated the Seminole.

The United States acquired Florida in 1819, and began urging the Indians there to leave their lands and relo-

M. Timothy O'Keefe, Bruce Coleman Inc

Seminole women in Florida wear their traditional tribal costumes, but the men usually wear ordinary work clothes.

cate to Indian Territory along with other southeastern tribes. Some Seminole leaders signed a treaty in 1832, and part of the tribe moved. They became one of the Five Civilized Tribes (see **Five Civilized Tribes**). But other Seminole refused to recognize the treaty, and fled into the Florida Everglades. The Second Seminole War, fought to force the Seminole west, began in 1835 and lasted seven years. It cost the United States about 1,500 men and more than $20 million. Osceola led the Seminole until he was tricked into discussing peace terms under a flag of truce. Instead, General Thomas Jesup ordered U.S. troops to seize and imprison him. Osceola died in prison in 1838 (see **Osceola**). Although many of the Indians finally agreed to move west, a small group remained in the Everglades.

A Third Seminole War broke out in 1855, when conflict arose between whites and some of the Seminole who had remained in Florida. The war ended in 1858, when the Indians agreed to move west. In 1970, the Indian Claims Commission awarded the Seminole $12,347,500 for the land taken away from them by United States military forces.

Today, many Seminole have small farms in Oklahoma. The Seminole who remained in Florida make a living by hunting, fishing, farming, raising cattle, or working in tourism or other industries. Some live in palm-thatched huts called *chickees*. These open shelters stand on platforms raised above the ground (see **Indian, American** [picture: The Seminoles]). Donald L. Fixico

See also **Black Seminole; Florida** (Territorial days).

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Semiramis, *sih MIHR uh mihs,* was a mythical queen of Assyria. She supposedly founded the ancient city of Babylon, and conquered Persia (Iran) and Egypt. She was the daughter of a Syrian youth and a fish goddess. Her mother left her, and she was fed by doves. Semiramis grew to be a beautiful woman and married King Ninus of Assyria. She became queen when he died, and won many battles, but her son overthrew her. Herodotus mentions a Semiramis who was queen of Babylon in the 700's B.C. C. Scott Littleton

Semites, *SEH myts,* are peoples who speak a Semitic language, such as Arabic or Hebrew. They live mainly in Eritrea, Ethiopia, Iraq, Israel, Jordan, Lebanon, Syria, the Arabian Peninsula, and North Africa. The ancient Assyrians, Babylonians, Canaanites, Eblaites, Hebrews, and Phoenicians also were Semites.

Semitic peoples gave the world the alphabet and the idea of one God. Three great religions—Judaism, Christianity, and Islam—originated among Semitic peoples.

The origin of the Semites is unknown, but some anthropologists believe these peoples may have been nomads who lived on the Arabian Peninsula. By about 3,000 B.C., the ancient Semites had moved to the lower part of Mesopotamia (now southeastern Iraq), the home of the Sumerian civilization (see **Sumer**).

A Semitic ruler named Sargon founded the first Semitic empire in the 2300's B.C. in Akkad, a city in Mesopotamia. Under Sargon's rule, Semitic and Sumerian culture spread through Mesopotamia. At about the same time, Semitic dynasties and states emerged in Syria.

Almost 3,000 years ago, Semitic peoples established colonies in parts of Africa, Sicily, and Spain. Semitic culture was later absorbed by non-Semitic peoples who moved into those three areas.

The word *anti-Semitism* means hatred of Jews or prejudice against Jews. But the term is misleading because not all Jews are Semites, and Semites include not only Jews but also Arabs and other peoples. John A. Brinkman

Related articles in *World Book* include:

Anti-Semitism	Babylonia	Phoenicia
Arabs	Ebla	Sargon of Akkad
Assyria	Jews	Semitic languages

Semitic languages, *suh MIHT ihk,* are among the world's oldest languages. They are generally divided into three categories: North East Semitic (Akkadian); North West Semitic (Hebrew, Aramaic, Eblaite); and Central and Southern Semitic (Arabic, South Arabian, Ethiopic). Amharic, Arabic, Hebrew, and Tigre are the principal spoken Semitic languages today. Aramaic survives as a spoken language in a small number of communities of Assyrian Christians in the Middle East.

Documents in Akkadian and Eblaite have been found on tablets written in *cuneiform,* an ancient writing system with wedge-shaped characters. The alphabets of the other Semitic languages developed from a common source. However, they gradually formed into the separate writing systems of Hebrew and Arabic used today. Roger Allen

See also **Alphabet; Arabic language; Aramaic language; Cuneiform; Hebrew language; Semites.**

Semmelweis, *ZEHM uhl vys,* Ignaz Philipp, *IHG nahts FEE lihp* (1818-1865), was a Hungarian doctor who first used antiseptic methods systematically in childbirth. In a clinic at the Vienna General Hospital in Vienna, Austria, he discovered that puerperal fever, which then killed about 13 percent of all mothers and newborns, was contagious, and that doctors were spreading the disease by not cleaning their hands after performing autopsies. He was ridiculed for this idea. But he maintained his stand, and in 1861 published his classic work on *The Etiology, Concept and Prophylaxis of Childbirth Fever.* Opponents of his ideas attacked him fiercely, and this battle eventually brought on a mental illness. The year of Semmelweis's death, the British surgeon Joseph Lister performed his first antiseptic operation, and soon afterward it was recognized that Semmelweis had been right. Semmelweis was born in Buda (now part of Budapest). Matthew Ramsey

Semmes, *sehmz,* Raphael (1809-1877), a rear admiral in the Confederate Navy, commanded the famous ship *Alabama* during the Civil War (1861-1865). When the *Alabama* was sunk off Cherbourg, France, in 1864, an English yacht rescued Semmes and took him to England. He returned home and took command of the James River squadron, which he had to destroy during the evacuation of Richmond in 1865. Semmes organized his troops into a land force but later surrendered at Greensboro, North Carolina. Semmes was born in Charles County, Maryland. He joined the Navy when he was about 17. After the Civil War, Semmes practiced law in Mobile, Alabama. See also **Alabama** (ship). Thomas L. Connelly

Sempach, Battle of. See Winkelried, Arnold von.

U.S. Capitol Historical Society (National Geographic)

The United States Senate, which has 100 members, meets in the Senate chamber of the United States Capitol, *shown here.* A gallery in the chamber allows visitors to watch the senators at work.

Senate is one of the two lawmaking bodies of many legislatures. In many of these legislatures, the other chamber is called a *house of representatives.* In most cases, the senate is smaller. Many countries have a national legislature with a senate, including the United States, Canada, Australia, France, and Italy. In the United States, a senate is one of two chambers in 49 state legislatures. Nebraska has a one-chamber legislature. This article deals chiefly with the United States Senate.

The U.S. Senate is one of the two houses of Congress. The other one is the House of Representatives, usually simply referred to as the *House.* The Senate is often referred to as the *upper house* and the House of Representatives as the *lower house.* Both houses have about the same amount of power, but the office of senator is considered a higher distinction than that of representative.

The House and Senate must pass identical versions of a bill before it can become law. The Senate can originate all types of legislation except tax laws. Only the Senate can approve treaties and the president's nominations to certain government offices.

Membership of the U.S. Senate

Size. The Constitutional Convention, which established the form of the national government in 1787, disagreed on the question of congressional representation. Delegates from the states that had small populations wanted equal representation for every state. But delegates from states with large populations called for representation according to population. A compromise provided for equal representation in the Senate—two senators from each state, regardless of population. The agreement set up representation in the House based on population. The first Senate had 22 members when it met in 1789 and 26 by the end of the first Congress. The Senate now has 100 members. Its membership reached 100 in 1959, when Hawaii became the 50th state.

Qualifications and election. The Constitution requires a U.S. senator to be at least 30 years old and to have been a citizen of the United States for at least nine years. Senators must maintain legal residence in the state they represent.

Today, voters elect all members of Congress. But the Constitution originally provided that the people elect only the House members, usually called *representatives.* State legislatures chose the senators and were expected to select wealthy, distinguished men who would promote conservative policies. But Senate elections distracted the legislatures from other duties. In 1913, the 17th Amendment to the Constitution gave voters the right to choose senators.

Senators serve six-year terms. About a third of all United States senators are chosen in the same year. There is no limit on the number of times a senator may be re-elected.

Salary and privileges. The basic salary of senators is $150,000. Senators are entitled to annual salary increases based on rises in the cost of living, but they may vote not to accept the increases. Each senator also gets an allowance to pay the salaries of his or her staff. The size of the staff allowance depends on the number of people in the senator's state.

Senators also have the use of Senate office buildings in Washington, D.C., and get an allowance for an office in their home state. They also receive extra allowances to hire legislative assistants and to pay for office and travel expenses. Senators and representatives have legal *immunity* (protection) for anything they write or say as members of Congress. This immunity enables them to make critical statements about people without fear of being sued.

Organization of the U.S. Senate

The leaders of the Senate hold special positions established by the Constitution or by the political parties. The Constitution provides that the vice president serve as *president of the Senate.* The vice president can preside over Senate debate but can vote only to break a tie. As a result, the vice president presides on ceremonial occasions or only when a close vote is expected on an important issue. The Constitution provides that the Senate choose a *president pro tempore* (temporary president) to preside when the vice president is absent. But the Senate usually gives this position to the senator of the *majority party* who has the longest continuous service. The majority party is the one with the most members in the Senate. Actually, the president pro tempore

rarely presides, and different temporary presidents guide debate in most sessions.

Party leaders in the Senate have much more power than the leaders specified by the Constitution. Party leaders are chosen at a meeting called a *caucus* or *conference,* which is held before each new session of Congress begins. Democratic and Republican members hold separate caucuses. The majority party selects the *majority leader* of the Senate. The other party elects the *minority leader.* Each party also chooses an assistant leader called a *whip.* The whip estimates forthcoming votes and tries to persuade party members to support the party's position. In addition, each party chooses a *policy committee,* which helps schedule bills for consideration and largely plans the legislative strategy of the party.

Senate committees, which consist of members of both parties, do most of the actual work of the Senate. Senators serve on four types of committees. These types are (1) *standing* (permanent), (2) select, (3) conference, and (4) joint.

Standing committees, the most important type, deal with bills concerning specific legislative subjects. The Senate has 16 standing committees, the most powerful of which include Appropriations, Armed Services, Foreign Relations, and Judiciary. Select committees, also called *special* committees, are temporary groups formed for investigations or other special purposes. Conference committees and joint committees consist of members of each house of Congress. Conference committees resolve differences in bills that have passed in both houses. Joint committees deal with topics that concern both houses, such as energy problems and economic matters.

Most Senate committees are divided into subcommittees, which handle much of the committee work. Members of the majority party head most of the committees and subcommittees. Members of both parties vote for committee heads. Often, however, the *seniority principle* determines who serves as the head of a committee. Under this principle, the majority party senator with the longest continuous service on a committee becomes the head.

AP/Wide World

Senate committees hold hearings to gather information about proposed laws. The committees decide whether to lay the bills aside or to recommend that the full Senate pass them.

Other members of committees are elected by the Senate. However, each party's caucus makes the committee assignments before the formal election. Every Senate committee has more members from the majority party than from the minority party.

The work of the U.S. Senate

Considering legislation is the Senate's chief task. After a senator introduces a bill, it is sent to a committee for study. The committee may lay the bill aside, keeping the Senate from voting on it, or release it with a recommendation to pass it. If a bill is released, it goes on a list for consideration by the Senate. The majority leader largely determines if and when such bills are considered.

The Senate considers most bills under a *unanimous consent agreement.* Such an agreement allows more flexible procedures than would otherwise be allowed. An objection from even one senator blocks a unanimous consent agreement. Most of these agreements include a limit on debate. Under the normal rules of the Senate, members may speak for as long as they wish on any topic whatsoever. Some senators occasionally use this freedom so they can make long speeches called *filibusters,* which prevent the Senate from voting. Small groups of senators sometimes use filibusters to force the withdrawal or changing of legislation that is favored by most members. To end a filibuster, the Senate can vote *cloture*—that is, to limit the debate. Cloture requires the support of at least three-fifths of the Senate.

Most bills require the support of only a simple majority—that is, more than half the senators present—to pass. A bill that the Senate has originated and passed is sent to the House, where it goes through a similar process. If both houses pass a bill, a conference committee may resolve any differences between the two versions of the legislation. After both houses pass identical versions of the bill, it goes to the White House for approval by the president. The bill becomes law if the president signs it or fails to act on it for 10 days—not including Sundays—while Congress is in session. A bill requires the president's signature to become law if it reaches the chief executive fewer than 10 days—not including Sundays—before Congress adjourns. If the president vetoes the bill, it is sent back to Congress. A vetoed bill becomes law if at least two-thirds of the members present in each House vote to *override* (reverse) the veto.

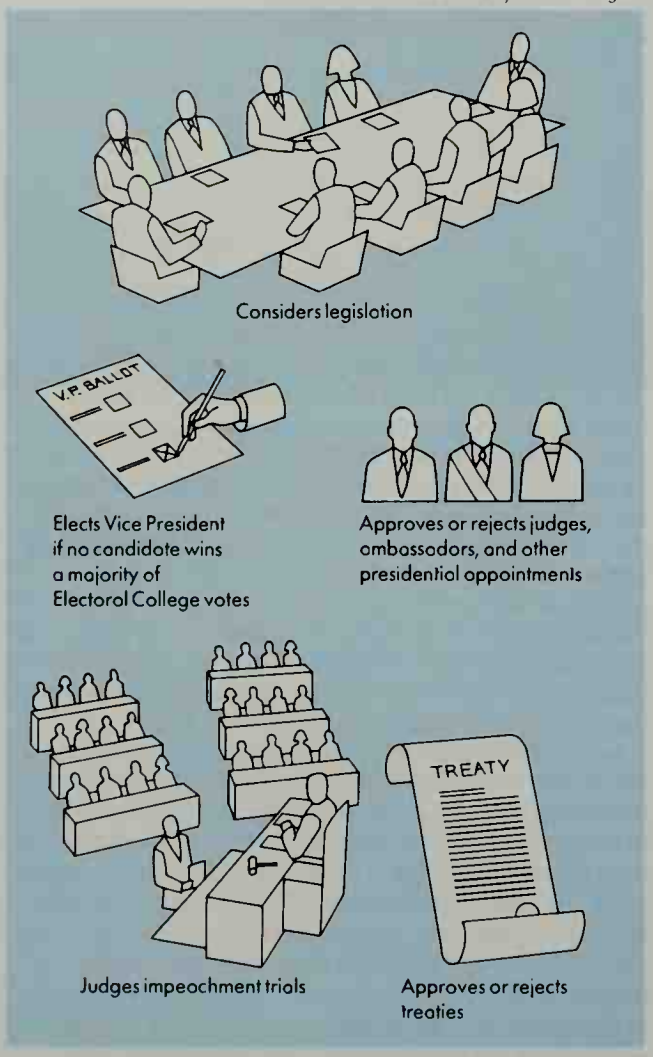
Other powers and duties of the Senate include four important nonlegislative functions. The Senate approves or rejects certain presidential appointments. It also approves or rejects treaties. The Senate elects the vice president if the Electoral College, the group of representatives chosen by the voters in presidential elections, fails to give any candidate a majority. In addition, the Senate judges *impeachment* cases brought against U.S. government officials by the House. Impeachment is a charge of misconduct in office.

Presidential appointments of ambassadors, federal judges, Cabinet members, and certain other officials are subject to approval by the Senate. The Senate votes on thousands of appointments yearly and usually gives close attention only to the most important ones. Under a custom called *senatorial courtesy,* the president confers with the senator or senators of his or her party from a

The work of the United States Senate

Considering legislation is the chief task of both the Senate and the House of Representatives. However, each of these bodies has several nonlegislative duties that are carried out independently. This chart shows the five main duties of the Senate.

WORLD BOOK illustrations by David Cunningham



state before nominating anyone for an office in that state. If the senator or senators do not approve of the appointment, the Senate almost always rejects it.

Any treaty made by the United States is subject to the approval of at least two-thirds of the senators present. This requirement limits the President's powers in foreign relations. A two-thirds vote of the Senate is also required for conviction in an impeachment case.

Senates in other countries

Almost half of all nations have a two-house legislature. However, not all upper houses are called senates. Many nations have representation by population in the lower house and equal representation for each state or province in the upper house.

Most upper houses not directly chosen by the voters have limits on their power. For example, the Canadian Senate, whose members are appointed by the governor general on the prime minister's recommendation, cannot introduce bills involving the spending of money, and cannot stop the passage of a constitutional amendment approved by the House of Commons. Ireland's senate, which is partly appointed and partly elected by other officials, is an advisory body. Kenneth Janda

Related articles in *World Book.* See the *Government* section of the article on each country mentioned, such as **Ireland** (Government). See the *Legislature* section of each state article, such as **Ohio** (Legislature). Other related articles include:

Canada, Government of (The Senate)
Cloture
Congress of the United States
Constitution of the United States
Filibustering
House of Representatives
Impeachment
Parliament (The House of Lords)
Political action committee
State government (Legislative branch)
Term limits
United States, Government of the
Vice President of the United States

Additional resources

Greenberg, Ellen. *The House and Senate Explained: The People's Guide to Congress.* Norton, 1996.

Harris, Fred R. *Deadlock or Decision: The U.S. Senate and the Rise of National Politics.* Oxford, 1993.

Sendak, Maurice (1928-), is an American illustrator and author of children's books. Sendak won the 1964 Caldecott Medal for his illustrations for *Where the Wild Things Are,* which he also wrote. The story tells about a boy named Max who deals with his emotions through the use of his imagination.

Sendak's books *In the Night Kitchen* (1970) and *Outside Over There* (1981) describe the adventures of children who master their feelings by testing themselves in dangerous but imaginary places. Several of Sendak's books are close observations of children at play, including *The Sign on Rosie's Door* (1960). In *We Are All in the Dumps with Jack and Guy* (1993), Sendak tells about an infant who finds friendship with two homeless men.

Sendak was born in the Brooklyn section of New York City. Many of his stories draw on his childhood there. Sendak has illustrated about 80 children's books, including about 20 that he wrote himself. He has also written books for adults and designed sets and costumes for operas. His essays on children's literature were collected in *Caldecott & Co.* (1988). Nancy Lyman Huse

See also **Literature for children** (picture: Illustrations).

Seneca, *SEHN uh kuh,* **Lucius Annaeus,** *LOO shih uhs uh NEE uhs* (4 B.C.?-A.D. 65), was a Roman statesman, author, and Stoic philosopher. His surviving works include 12 philosophic essays, 124 letters, a meteorological essay, a satire, and 9 tragedies. His tragedies adapt subjects used by the Greek playwrights. But they are intense, violent melodramas full of rhetorical language. They focus on the Stoic belief that disaster results when passion destroys reason. Seneca's tragedies influenced tragic drama in Italy, France, and Elizabethan England.

Seneca was born in Spain into a distinguished Roman family. He was prominent in political and literary life in Rome. Later he became the tutor and adviser of the Emperor Nero. Nero accused Seneca of plotting his death, and forced him to commit suicide. Norman T. Pratt

See also **Geology** (The Romans).

Seneca Indians are a tribe who once occupied an area from the Genesee River to Canandaigua Lake in western New York. Their Seneca name is *O-non-dowa-gah,* which means *people of the great hill.* The name refers to a hill near Canandaigua Lake where, according to a Seneca legend, the tribe originated.

The Seneca were the largest of the five tribes that had

joined together by about 1100 to form the Iroquois League or the Five Nations. The other member tribes were the Cayuga, Mohawk, Oneida, and Onondaga. About 1722, the Tuscarora joined the Iroquois League, which then became known as the Six Nations. Within the league, the Seneca were called *keepers of the western door* because their land made up the westernmost part of the Iroquois territory. See **Iroquois Indians**.

Like other Iroquois, the Seneca once built their villages on hills near a river. A tall wooden stake fence surrounded most settlements to protect them from attack. Seneca villages included 30 to 150 large rectangular dwellings called *long houses,* each of which provided shelter for several related families.

According to the 1990 United States census, there are about 9,000 Seneca. Most of the Seneca live on three reservations in western New York: (1) the Allegany Reservation, (2) the Cattaraugus Reservation, and (3) the Tonawanda Reservation. They make up two separate political groups, the Seneca Nation of Indians and the Tonawanda Band of Seneca.

The Seneca Nation was formed in 1848, when the residents of the Allegany and Cattaraugus reservations abolished the system of government by chiefs. Some of these reservations' chiefs, who were permanent leaders, were corrupt. The two reservations adopted a constitution, which established a government headed by elected officials. The Tonawanda Reservation has maintained the traditional governing council of chiefs. Other Seneca live in Oklahoma and in Ontario. Robert E. Powless

See also **Cornplanter; Handsome Lake; Red Jacket.**

Senefelder, *ZAY nuh FEHL duhr,* **Alois,** *AH loys* (1771-1834), invented the process of lithography (see **Lithography**). As a young man, Senefelder wrote plays. Because he could not get them published, he tried to print them himself. While preparing to etch a stone slab, he wrote on it with a wax crayon and found that the marks could be inked and printed. He was born in Munich, Germany. Peter M. VanWingen

Senegal, *SEHN uh GAWL,* is a small country located on the northwest coast of Africa. It is at the tip of the bulge of northern Africa jutting west toward the Atlantic Ocean. It is farther west than any other African mainland nation.

Rolling plains cover most of Senegal. The tiny nation of Gambia divides the southern part of Senegal, called the *Casamance,* from the larger northern part. The vast majority of Senegal's people are black Africans. Dakar is the country's capital, largest city, and commercial center.

Senegal became an independent nation in 1960. It had been ruled by France since the late 1800's.

Government. Senegal is a republic. The president is the most powerful governmental official. The president is elected by the people to a five-year term and can be reelected only once. The president appoints a prime minister and Cabinet members to carry out government operations.

The National Assembly makes Senegal's laws. The Assembly has 120 members, who are elected by the people to five-year terms. Senegal's judicial system includes the Constitutional Council, the Council of State, the Supreme Court of Appeal, and the Audit Office.

All citizens 21 years old and older may vote. Senegal has a number of political parties, including the Socialist

WORLD BOOK maps

Party of Senegal and the Senegalese Democratic Party. The Socialist Party controlled the Senegalese government from the time the country became independent in 1960 until 2000.

People. Approximately 95 percent of Senegal's people are black Africans. They belong to many different ethnic groups. The largest ones are, in order of size, the Wolof, Fulani (or Fula), Serer, Toucouleur, Diola, and Mandingo. Each group has its own customs and language.

Senegal also has a large immigrant population made up of people from other African countries and from

Facts in brief

Capital: Dakar.
Official language: French.
Official name: République du Sénégal (Republic of Senegal).
Area: 75,955 mi² (196,722 km²). *Coastline*—310 mi (499 km).
Elevation: *Highest*—1,634 feet (498 meters), in the southeast. *Lowest*—sea level.
Population: *Estimated 2002 population*—9,969,000; density, 131 per mi² (51 per km²); distribution, 59 percent rural, 41 percent urban. *1988 census*—6,896,808.
Chief products: *Agriculture*—peanuts, millet, cassava, cotton, poultry, rice, vegetables. *Manufacturing and processing*—peanut products, fish products, refined petroleum, flour milling. *Mining*—phosphates.
Flag: The flag has green, yellow, and red vertical stripes. A green star lies in the center of the yellow stripe. See **Flag** (picture: Flags of Africa).
National anthem: "Pincez Tous Vos Koras, Frappez les Balafons" ("Pluck Your Koras, Strike the Balafons").
Money: *Basic unit*—franc. One hundred centimes equal one franc.

Joseph F. Viesti, FPG

Rural houses in Senegal typically have mud walls and thatched roofs. In many cases, related families group their houses in a compound, where they share meals and chores.

George Holton, Photo Researchers

An Independence Day festival in Dakar, the capital of Senegal, is marked by the display of the national flag and the playing of *koras,* stringed instruments made from gourds.

France and Lebanon. French is Senegal's official language, but Wolof is the most widely spoken language in the country.

About 85 percent of Senegal's people are Muslims. The rest are either Christians or people who practice traditional African religions. Most Senegalese Muslims belong to Islamic religious groups called *brotherhoods.* The two largest groups are the Muridiyya (or Mouride) brotherhood and the Tidjaniyya brotherhood. Brotherhoods are led by Muslim religious leaders called *marabouts.* Marabouts are important in Senegalese politics because they can influence the way their followers vote.

Most of the rural houses in Senegal are mud huts with thatched roofs. In many cases, related families live together in a *compound* (cluster of houses) surrounded by a wall or fence. In the cities, middle-class people live in modern apartments or bungalows. The poor live in flimsy dwellings made of mud, sticks, or boards.

Most Senegalese men wear wide-legged trousers and a loose-fitting cotton robe called a *boubou.* The women wear brightly colored boubous, jewelry, and fancy turbans. The basic food of most Senegalese is a kind of grain called *millet.* Favorite dishes include chicken stew, spicy fried fish, and meat or fish with peanut sauce.

Senegal faces severe health problems. Water and food contaminated by parasites and other impurities is a major cause of illness and death in the country, especially in the rural areas. Senegal has a severe shortage of physicians.

Most of Senegal's adult population cannot read or write. For the country's literacy rate, see **Literacy** (table: Literacy rates). Children are required by law to complete six years of schooling, but the law is not enforced.

E. G. Ahounou, Stockphotos

The University of Dakar is Senegal's only university. It offers a variety of courses, and specializes in local African studies. Its modern library, *left,* is an outstanding architectural feature of the campus.

About 55 percent of Senegal's children attend elementary school, and 10 percent go to high school. Relatively few Senegalese attend college. The University of Dakar is Senegal's only university.

The Senegalese are noted for the striking wooden carved masks they produce and for their artistic traditional dances. The government of Senegal regularly sponsors exhibits of art from Senegal and from other African countries.

Land and climate. Sandy beaches cover Senegal's coast, which extends about 310 miles (500 kilometers) along the Atlantic Ocean. High sand dunes rise along the northern part of the coast. Dakar lies along the coast, on a peninsula called Cap Vert. Inland, Senegal's terrain consists mainly of gently rolling plains covered with reddish sand. The foothills of the Fouta Djallon mountain range rise in the southeast, near Senegal's border with Guinea.

Forests cover the Casamance region in southern Senegal. Farther north, the amount of plant life gradually decreases. Much of Senegal's wildlife has been eliminated by hunting and by the use of land for housing and other development. However, antelope, crocodiles, chimpanzees, elephants, and other kinds of wildlife still live in the eastern and southern parts of the country. Senegal has three major rivers—the Sénégal in the north, the Gambia in the southeast, and the Casamance in the southwest.

Senegal has a rainy season that lasts from July to October and a dry season that lasts from November to June. The greatest amount of rainfall occurs in the Casamance, which receives about 60 to 70 inches (150 to 180 centimeters) annually. The amount of rainfall gradually decreases farther north, averaging less than 20 inches (50 centimeters) near the Sénégal River. The average annual temperature along Senegal's coast is about 71 °F. (22 °C). Inland, the average annual temperature is about 84 °F. (29 °C).

Economy. Senegal is a developing nation. Poverty is widespread in the country. However, economic conditions have improved gradually since independence.

About three-fourths of Senegal's people work in agriculture. Senegalese farmers raise millet, cassava, rice, vegetables, and other crops for their own use. The farmers' main source of income comes from the sale of peanuts. Poultry and cotton are also important income-producing farm products.

The processing of peanuts into peanut oil and oil cakes ranks as Senegal's chief industry. Other important industries include fishing, the processing of fish, flour milling, and the refining of petroleum imported from Algeria and Gabon. Phosphates from lime deposits are Senegal's chief mineral products.

Peanuts, phosphates, and fish products rank as Senegal's leading exports. Major imports include food, machinery, and electric equipment. The country imports all of its petroleum and coal because it has no natural supplies of these minerals. France has been Senegal's main trading partner since the 1800's. But today, trade is growing between Senegal and other developing countries in Africa and elsewhere. About three-fourths of Senegal's foreign trade goes through Dakar, which has one of the busiest ports in Africa.

Senegal has one of the finest transportation systems in western Africa. The system includes about 6,800 miles (11,000 kilometers) of roads and about 700 miles (1,100 kilometers) of railroads. An international airport is located in Dakar. One major newspaper and several magazines are published in Senegal. The country has an average of about 1 radio for every 12 people and 1 TV set for every 100 people.

Cynthia Foster

Senegal's inland terrain consists mainly of rolling hills covered with reddish sand. Forested sections lie in southern Senegal, where antelope and other kinds of animals live.

History. The area that is now Senegal has probably been inhabited by black Africans since prehistoric times. The ancient West African empires of Ghana, Mali, and Songhai controlled eastern parts of the area from the A.D. 300's through the 1500's. Between the 1000's and 1300's, independent kingdoms arose in Senegal, including the Toucouleur kingdom in the north and the Serer and Wolof kingdoms near the central region.

In the mid-1400's, Portuguese sailors discovered the mouths of the Sénégal, Gambia, and Casamance rivers. They sailed into the interior of Senegal and began trading with the people. England, France, and the Netherlands took over the trade from the Portuguese during the 1500's. By the mid-1600's, the Europeans had established trading posts along the coast. The Europeans bought slaves along the coast. They traded such goods as alcohol, cloth, jewelry, iron bars, and weapons for gold, ivory, millet, ostrich feathers, and other goods. The Europeans introduced peanuts into the area as a food crop for the slaves.

England, France, and the Netherlands fought each other for possession of the trading posts. The Netherlands lost its posts in the late 1600's. In 1817, the English turned over their last possessions in Senegal to the French. During the mid-1800's, French troops conquered the independent kingdoms in the interior of what is now Senegal. In 1882, France made Senegal a French colony with four administrative districts. In 1895, the colony became part of a large federation of French territories called French West Africa. Dakar became the federation's capital.

The period of French rule resulted in many changes in Senegal. For example, marabouts replaced tribal chiefs as landlords and political leaders. The chiefs had lost much of their authority after France conquered their

kingdoms. In addition, the French encouraged the Senegalese to increase the production of peanuts for export to make the colony economically self-sufficient. The French also established many schools in Senegal.

Many Senegalese began demanding independence during the mid-1900's. Senegal gained control of its internal political affairs in 1956. In 1959, the country joined the French Sudan (now Mali) to form the Federation of Mali. The federation gained independence from France on June 20, 1960. On Aug. 20, 1960, Senegal withdrew from the federation and became the Republic of Senegal. Léopold Sédar Senghor, the founder of the Socialist Party of Senegal, became the country's president.

In 1962, Prime Minister Mamadou Dia was arrested for trying to overthrow President Senghor. Dia and others were tried and convicted. They were imprisoned from 1963 to 1974. In 1963, Senegal adopted a new constitution that eliminated the office of prime minister. However, in 1970, the people voted to restore the office. Severe droughts during the late 1960's and the 1970's seriously damaged Senegal's economy. The droughts caused widespread food shortages and other problems.

In 1981, Senghor resigned as president. Prime Minister Abdou Diouf succeeded him.

Since the early 1980's, fighting has sometimes broken out in the southern region of Casamance between government forces and rebels of the Movement of Democratic Forces of Casamance (MFDC). Members of this movement support independence for Casamance. Thousands of people have died in the fighting.

Senegal held elections for president in 2000. Abdoulaye Wade, leader of the Senegalese Democratic Party and the candidate of a coalition of opposition parties called the Alternance Front, defeated Diouf, the Socialist Party candidate. In January 2001, the nation adopted a new Constitution. Lucy E. Creevey

See also **Dakar; French West Africa; Gorée; Senghor, Léopold Sédar; Clothing** (picture: Traditional costumes).

Senescence. See **Aging; Geriatrics; Senility.**

Senghor, *san GAWR,* **Léopold Sédar,** *lay aw PAWLD say DAHR* (1906-2001), was president of Senegal from 1960 to 1981. He also became famous for his poetry and his writings on politics, culture, and society.

Senghor was born on Oct. 6, 1906, in Joal, near Mbour, Senegal. Senegal was then part of the French colonial federation known as French West Africa. Senghor graduated from the University of Paris in 1931. He was a professor of Latin and of French language and literature in France in the 1930's and 1940's. Senghor and other black poets in Paris developed *négritude,* a philosophy that emphasized black racial and cultural pride.

Senghor became a representative of Senegal in the French National Assembly in 1946. In 1959, Senghor became one of the principal leaders of the Federation of Mali, a union between Senegal and what is today Mali. The union collapsed in August 1960. Senegal then became an independent nation, with Senghor as president. Senghor helped promote economic progress and political stability in Senegal. His critics charged that he failed to bring about major social reforms and that he maintained too close ties with France, the former colonial ruler. Senghor resigned as president in 1981.

In his writings—which began in the 1930's—Senghor promoted black African civilization and opposed more materialistic cultures of the West. He won several poetry awards. In 1983, Senghor became the first black to be elected to the French Academy, an organization of scholars and writers. Edris Makward

Senility, *suh NIHL uh tee,* is a term sometimes used to describe certain mental problems that affect some elderly people. These problems actually may be symptoms of any of a large number of conditions with a large number of causes. Thus, most experts on the elderly avoid using the term. None of the conditions associated with the term is an unavoidable part of aging, and many can be helped by prompt medical treatment.

The main symptoms associated with so-called senility include a serious loss of memory and a decreased ability to perform such mental tasks as reading or arithmetic. People with such problems may tend to forget the time and where they are. They may fail to recall common facts or to recognize people they know well. A variety of permanent or temporary physical changes in the brain can produce these symptoms. The two most common brain diseases that cause permanent damage are *multi-infarct dementia* (a more accurate term for what was once called *cerebral arteriosclerosis*) and *Alzheimer's disease.* In multi-infarct dementia, arteries that nourish the brain become partially blocked and cannot supply the brain with enough oxygen-rich blood. As a result, the victim suffers a series of small strokes that destroy much brain tissue. Alzheimer's disease gradually destroys brain cells. Its cause is not fully understood.

Many other conditions, including head injuries, thyroid diseases, drug overdoses, and poor nutrition, can produce the symptoms of multi-infarct dementia or Alzheimer's disease. In most cases, the symptoms can be eliminated by medical treatment. But such conditions can result in permanent brain damage if untreated.

Depression can cause serious loss of memory or confusion in older people. If depression is suspected, the person and his or her family should seek the advice of a neurologist, psychiatrist, or *geriatrician* (physician who specializes in diseases of old age). Edward L. Schneider

See also **Aging; Alzheimer's disease; Geriatrics.**

Senior citizen. See **Old age.**

Sennacherib, *suh NAK uhr ihb* (reigned 704-681 B.C.), was king of Assyria, in what is now northern Iraq. Sennacherib ruled the Assyrian Empire during a period of revolt and war. He fought a long series of battles against Babylonia and its allies from Elam, in what is now Iran.

Sennacherib succeeded his father, Sargon II, as king. In 703 B.C., he ended a revolt of the Babylonians and Elamites led by Merodach-Baladan. Merodach-Baladan had been king of Babylonia until defeated by Sargon and was trying to regain his throne. Cities in Syria and Palestine revolted in 701 B.C. Sennacherib regained all except Jerusalem, from whose ruler, Hezekiah, he forced *tribute* (payment). Sennacherib crushed a revolt in Babylonia in 689 B.C. and looted the city of Babylon. He made Nineveh Assyria's royal capital and increased the city's splendor. In 681 B.C., his sons murdered him, probably to avenge his ruthless treatment of the sacred city of Babylon. Norman Yoffee

See also **Library** (Ancient libraries of clay).

Sennett, *SEHN iht,* **Mack** (1884-1960), was a pioneer motion-picture director and producer who became fa-

mous for his slapstick silent comedies. Many of the top silent comedy stars appeared in his Keystone films. His violent and vulgar film world challenged social authority. His famous Keystone Kops, instead of imposing order, added to the chaos. Sennett's bathing beauties fell for rascals, played by comics like Roscoe "Fatty" Arbuckle, rather than respectable beaus. These and other characters were often involved in famous chases that ended in spectacular crashes at the close of many Sennett films.

Sennett was born in Danville, Que. His real name was Michael Sinnott. He directed and produced hundreds of silent short comedies, beginning in 1911. His career came to a virtual end soon after the arrival of sound films in the late 1920's. Robert Sklar

Wisconsin Center for Film and Theatre Research

A Mack Sennett comedy called *Tillie's Punctured Romance* (1914) featured three famous silent film stars. They were, *left to right,* Charlie Chaplin, Marie Dressler, and Mabel Normand.

Senses are the means by which many-celled animals tell what is happening in their environment. Many people think that human beings have only five senses—hearing, sight, smell, taste, and touch. However, there are other kinds of senses that also give information about the position and movement of the body and about the body's needs. These senses include balance, hunger, pain, and thirst.

Scientists divide the senses into two groups. *External senses* receive information about the outside environment—about things outside the body. The external senses include hearing, sight, smell, taste, and touch. They also include the sense of heat, which is felt by special *receptor* (receiver) cells in the skin. *Internal senses* receive information about the internal environment—about the changes that occur in the body's organs and tissues.

External senses. Some external senses detect things that occur far from the body, and others detect things that come in contact with the body. We detect things in the distant outside environment with our senses of sight, hearing, and heat. These senses are called *distance receiving senses.* They require only a small stimulus to respond. This high level of sensitivity is necessary

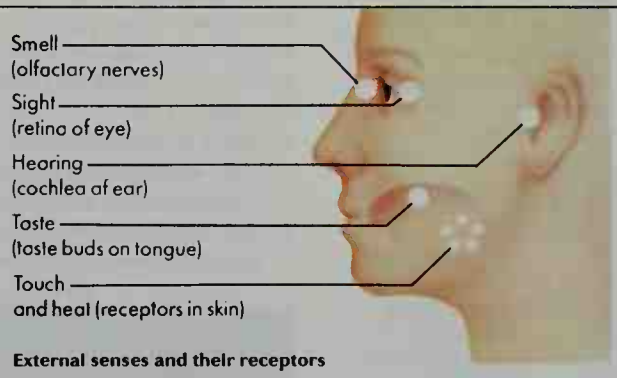
Our external and internal senses

Our senses are divided into two main groups. *External senses* tell us about things that occur far from the body and that come in contact with it. *Internal senses* give us information about changes that occur in the tissues and organs inside our bodies.

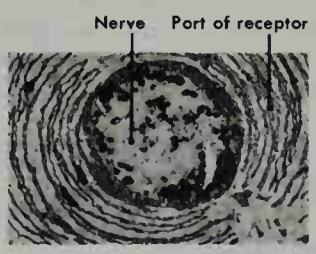
WORLD BOOK illustrations by Charles Wellek

External senses

The external senses of hearing, heat, and sight tell us about things that happen far from the body. The external senses of taste, touch, and smell tell us about things that come in contact with the body. The diagram at the right shows where the receptors of these senses are located.



External senses and their receptors

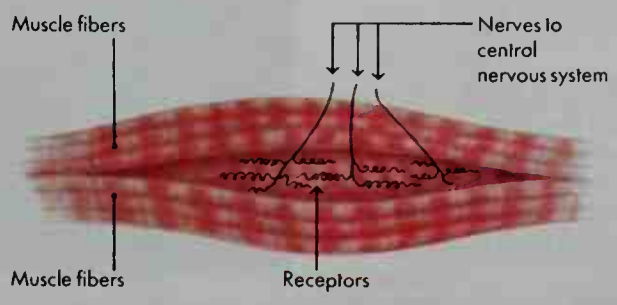


Dr. Y. Ibata

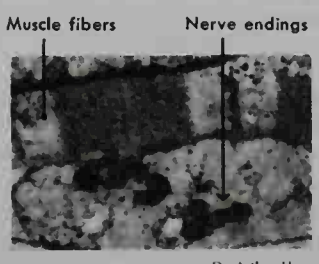
The end of a nerve is magnified 2,000 times. The nerve leads from a touch receptor.

Internal senses

The internal senses send messages to the brain about changes inside the body. The senses control such feelings as fatigue, hunger, pain, and thirst. They also respond to tension in the muscles. The diagram at the right shows the receptors that sense tension in muscle fibers.



Receptors of the internal sense of muscular tension



Dr. Arthur Hess

Nerves of a muscle tension receptor, magnified 6,000 times, connect to muscle fibers.

because the stimulus may occur far away from the sense receptor. Therefore, the amount of energy that actually reaches the sense receptor is often very small.

The senses of taste, touch, and smell involve contact with the body and are called *contact external senses.* These senses require a fairly large stimulus in order to respond. For example, many thousands of molecules of a substance must be present for something to be tasted. Relatively heavy pressure must be applied to the skin for an object to be felt. Because these stimuli occur at the receptors, contact external senses do not need high sensitivity.

Internal senses detect changes that take place inside the body and send messages about these changes to the brain. The internal senses respond to chemical and physical stimuli in the circulatory, digestive, excretory, respiratory, and central nervous systems. They contribute to such feelings as hunger, fatigue, pain, and thirst. They also respond to the position and movement of the head and the joints, and to tension in the muscles. By responding to these chemical and physical changes, internal senses help maintain a proper environment inside the body. In addition, they provide information on relationships that exist between the body and the outside world.

The internal senses can be highly sensitive to small changes in the amounts of chemicals that are usually present in the body. This high sensitivity is necessary because the internal receptors must maintain a rather constant internal environment for life to continue. The receptors that respond to chemical changes in the body are called *internal chemoreceptors.*

Some animals respond to environmental stimuli that cannot be detected by human senses. These stimuli include ultraviolet light, the earth's magnetic field, sounds of very high and very low frequencies, and extremely small electric currents in water.

By studying the senses, scientists are able to determine what things in the environment are important to each kind of animal. Scientists also learn about the environment in which the *evolution* (gradual development) of particular groups of animals occurred.

Bruce P. Halpern

Related articles in *World Book* include:

Amphibian (Senses)
Animal (Adaptations for sensing the environment)
Bird (Senses)
Blindness
Brain
Deafness
Ear
Eye
Hunger
Insect (The senses)
Mammal (Senses)
Nervous system
Nose
Pain
Perception
Sleep
Smell
Taste
Thirst
Touch

Sensitive plant is a small, spreading shrub that grows in tropical regions of the Western Hemisphere. The plant is called *sensitive* because its leaflets fold together when they are touched or exposed to strong fumes. At the same time, the leafstalks bend toward the main stem, as though they were shrinking from being touched.

Sensitive plants are sometimes grown in greenhouses as curiosities. Sensitive briers of the southern United States also close when handled roughly. Leaves of many members of the pea family close at night.

Daniel F. Austin

Scientific classification. The sensitive plant belongs to the pea family, Fabaceae or Leguminosae. It is *Mimosa pudica.*

See also Telegraph plant.

Sensitivity training is a learning process designed to develop an individual's self-awareness and sensitivity to other people and the environment. Sensitivity training takes place in a group of from 8 to 20 persons, including a leader. Members of this *encounter group* speak openly about their feelings and reactions to others in the group. Some group leaders involve members in various *games* to produce strong emotional experiences. These games include such activities as having two members stare into each other's eyes, or having a member act out a feeling of affection or anger.

Some psychologists regard sensitivity training as a major development in their field. They believe it can make a person more aware of inner feelings and help the person get along more effectively with others. Some educators use sensitivity training techniques in teaching. Business people attend encounter groups to learn how to work more productively with others.

Other psychologists criticize sensitivity training. They call it experimental and claim that its effectiveness has not been proved. They declare that many group leaders lack proper training. Such critics also believe that encounter groups do not take enough care to exclude people who might react badly to sensitivity training. They point out that some participants have been physically or psychologically injured at meetings.

Kurt Lewin, a German-born psychologist, conducted the first encounter group at an interracial workshop in New Britain, Connecticut, in 1946. The Esalen Institute in Big Sur, California, developed and popularized sensitivity training during the 1960's. David Hothersall

Sensory neuron. See Nervous system (How the nervous system works).

Sentence is a series of words arranged into a meaningful unit. It begins with a capital letter and ends with a punctuation mark—a period, a question mark, or an exclamation point. A grammatically complete sentence consists of an independent group of words that has a subject and a predicate. The predicate must include a *finite verb.* Such a verb, with a subject, can form a sentence—for example, *The lightning flashed.*

The group of words *The potatoes cooking* has a sub-

Runk/Schoenberger from Grant Heilman

Leaves of the sensitive plant react quickly after they are touched or exposed to strong fumes. The open leaves are shown at the left. After being touched, they fold up tightly, *right.*

ject, but it is not grammatically complete because it lacks a finite verb. *The potatoes are cooking* is a grammatically complete sentence because it has a subject and a finite verb. *When the potatoes are cooking* is not a sentence because it is not an independent group of words. The word *when* makes it a subordinate clause. Sentences must be main clauses. See **Clause.**

Subject and predicate. The subject of a sentence consists of a noun or another word used as a noun, plus its modifiers. The subject tells what is being spoken about. In *The latest issue of the magazine arrived today,* the subject is *issue.* The modifiers are *The, latest,* and *of the magazine.* Together, the six words form the *complete subject.* In *Vigorous bicycling is good exercise,* the subject is *bicycling.* Its modifier is *vigorous.* The two words together make up the complete subject.

A predicate consists of a finite verb, along with its object or complement and their modifiers. The finite verb may be transitive, intransitive, or a linking verb. A *transitive* verb passes the action from the subject to a direct or indirect object. The meaning of an object may be completed by a noun or adjective called a *predicate complement.* An *intransitive* verb describes a completed action and needs no object. A *linking verb* connects the subject with a predicate noun, pronoun, or adjective that completes the meaning of the subject and is called a *subjective complement.* See **Verb.**

As a unit, the predicate tells something about the subject. In *Our class sold homemade cookies, sold homemade cookies* says something about the subject *Our class.* The verb is *sold;* the object is *cookies,* and its modifier is *homemade.* Together, they form the *complete predicate.* In *The young boy became very ill, became very ill* comments upon the subject *The young boy. Became* is the verb; *ill* is the predicate complement, and *very* is its modifier. Together, they form the complete predicate.

A *compound subject* consists of two or more nouns: *Hydrogen and oxygen combine to form water.* A *compound predicate* consists of two or more finite verbs: *Water can be frozen into a solid or can be heated into a gas.*

Sentence classifications. A sentence can be classified by its purpose. If the purpose of a sentence is to state a fact, it is a *declarative* sentence: *I found a dollar.* If it asks a question, it is an *interrogative* sentence: *Did you find a dollar?* If it gives a command or makes a request, it is an *imperative* sentence: *Lend me a dollar, please.* If it expresses strong feeling, it is an *exclamatory* sentence: *How lucky I was to find a dollar!*

A sentence can also be classified by its grammatical form. A *simple sentence* has one subject and one predicate: *The wind blew fiercely.* But either the subject or the predicate can be compound: *Oranges and lemons are citrus fruits* has a compound subject. *The cat snarled and scratched* has a compound predicate.

A *compound sentence* joins two or more simple sentences. They are joined with a conjunction, such as *and, but, or, for, nor,* or *yet: I wrote her, but she did not reply.* A *complex sentence* consists of a main clause and one or more subordinate or dependent clauses: *Animals bite when they are teased or when they are attacked.*

Sentence patterns. The variety of English sentences may be shown by examining how several basic sentence patterns can be changed. Such basic patterns are sometimes called *kernels.*

Pattern I

Subject	Intransitive verb	(Optional adverb)
Thorns	*hurt*	(*badly*).
The fish	*are biting*	(*today*).

Pattern II

Subject	Transitive verb	Direct object	(Optional objective complement)
The farmer	*planted*	*beans.*	
The teacher	*appointed*	*him*	(*chairman*).

Pattern III

Subject	Transitive verb	Indirect object	Direct object
Singing	*gives*	*me*	*pleasure.*
John	*made*	*himself*	*a guitar.*

Pattern IV

Subject	Linking verb	Predicate noun
Mrs. Haley	*is*	*my teacher.*
He	*turned*	*traitor.*

Pattern V

Subject	Linking verb	Predicate adjective
Prices	*are*	*high.*
His voice	*sounded*	*thin.*

Basic sentence patterns can be added to, reduced, combined, and rearranged in many ways. The construction of sentences affects the clarity, emphasis, and pace of speaking and writing. A speaker varies sentences naturally, but a writer must do so consciously. Changing the parts of a sentence to vary a basic pattern is called *transformation.* Below are some transformations.

1. Some patterns may be changed from the active voice to the passive voice.
   Kernel: *The city sponsored the parade.*
   Passive: *The parade was sponsored by the city.*
2. All patterns may be transformed into emphatic and negative statements.
   Kernel: *She lives nearby.*
   Emphatic: *She does live nearby.*
   Negative: *She does not live nearby.*
3. All patterns may be transformed into various questions.
   Kernels: *They picked berries.*
   They were picking berries.
   Yes-and-no question: *Did they pick berries?*
   Information question: *When did they pick berries?*
   Intonation question: *They picked berries?*
4. Many patterns may be changed into imperative statements.
   Kernel: *You compared the two boats.*
   Imperative: *Compare the two boats.*
5. Many patterns may be transformed into exclamatory statements.
   Kernel: *We were happy.*
   Exclamatory: *How happy we were!*
6. All patterns may be changed into subordinate structures of different kinds.
   Kernels: *Paul was a good captain.*
   Paul sailed to Easter Island.
   Subordination: *Paul, who was a good captain, sailed to Easter Island.*
   Paul, a good captain, sailed to Easter Island.
   As Paul was a good captain, he sailed to Easter Island.
7. Most patterns may be transformed into statements introduced by *there* or *it.*
   Kernels: *Seven versions of that song are known.*
   The song is well known.
   There transformation: *There are seven known versions of that song.*
   It transformation: *It is true that the song is well known.*
8. Many patterns may be compressed into modifiers.
   Kernel: *The cherries tasted sweet.*

Modification: *The sweet-tasting cherries . . .*

9. Many patterns may be combined to form compound structures.

Kernels: *My glasses fell.*
My glasses broke.

Combination: *My glasses fell and broke.*

10. The parts of many patterns may be transposed to other positions in the sentence.

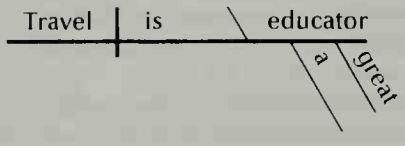
Kernel: *He kept down the price.*

Transposition: *He kept the price down.*

Sentence fragments are common, especially in speech. Sentence fragments appear after many questions. For example, the question *Where were you?* could be answered by the phrase *At the beach.* The answer is a sentence fragment that stands for the complete sentence (*I was*) *at the beach.*

Diagraming is a form of sentence analysis that shows how each part of a sentence is related to another. The diagram below divides the subject from the verb, the verb from its complement, and the complement from its modifiers.

Travel is a great educator.



Diagraming serves primarily as a teaching device. The forms of diagraming vary from the traditional model above to extremely complex diagrams used by modern linguists. Patricia A. Moody

See also Grammar.

Sentence is a penalty a person must pay if convicted in court of committing a crime. A sentence may be determined by a judge or a jury, or by a law. In the United States, convicted criminals may be (1) required to pay a fine, (2) placed on probation, (3) sent to prison, or (4) executed. In some cases, criminals may be fined in addition to being placed on probation or imprisoned.

Sentences have several purposes. For example, a sentence puts a criminal in prison to prevent the person from hurting others. Some law enforcement experts believe sentences *deter* (discourage) crime by showing a potential criminal the result of breaking the law. Many people think the main purpose should be to punish criminals. They also believe the harshness of a sentence should depend on the seriousness of the crime. Others believe sentences should *rehabilitate* criminals—that is, change them into law-abiding citizens.

For many years, there were few guidelines for sentencing criminals, and judges did so according to their own judgment. Since the early 1900's, many states have passed laws specifying an *indeterminate* (indefinite) sentence for a particular crime. For example, a sentence for armed robbery might range from 5 to 20 years. In such cases, a judge or jury imposes the sentence, and a parole board determines when the prisoner is released. As a result, many criminals who commit the same crime do not serve the same sentence.

In the late 1970's, many states adopted systems of *fixed sentences.* Such systems limit or abolish parole. They require criminals to stay in prison for a specific period of time, depending on the crime. For example, a bank robber might receive a sentence of four to five years. Many experts believe fixed sentences discourage crime and make sentencing more just. Others think judges should be able to vary sentences, depending on the circumstances of the crime.

In 1987, new federal sentencing guidelines went into effect in the United States. These guidelines reduced the role of judges in setting prison terms for federal crimes. The guidelines divided such crimes into 43 categories. More serious crimes were placed in categories that demanded longer sentences. The three most serious crimes—first-degree murder, aircraft hijacking resulting in death, and treason—required life imprisonment. The guidelines also abolished parole. However, the length of a prison term could be reduced for good behavior. The federal sentencing guidelines do not apply to cases handled by the state courts. James O. Finckenauer

Seoul, *sohl* or *SOH ool* (pop. 10,612,577), is the capital and largest city of South Korea. Seoul ranks as one of the largest cities in the world in population. In addition, Seoul serves as the center of South Korea's cultural, economic, educational, financial, governmental, and political activities.

Seoul is located in northwestern South Korea, about 20 miles (32 kilometers) east of the Yellow Sea. The Han River flows through the city. Since the mid-1900's, Seoul has expanded rapidly. As a result, modern skyscrapers tower above beautiful old palaces and pavilions.

Seoul was founded in 1394 as the capital of the kingdom of *Choson* (the name for Korea at that time). The city's name means *capital.*

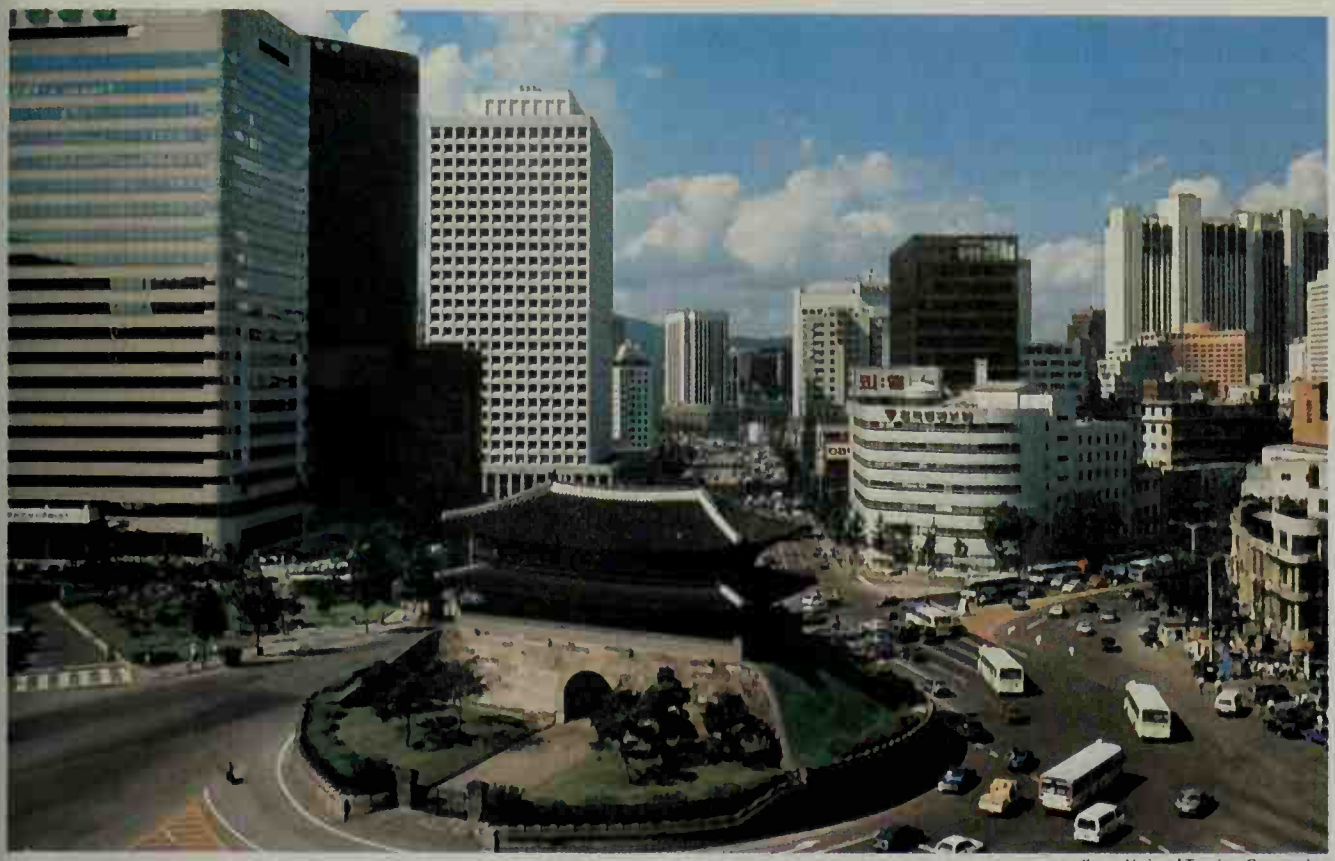
The city. Seoul was originally established north of the Han River, in a small valley almost completely surrounded by mountains. The high peaks provided a natural barrier against enemies. During the city's construction in the 1390's, a wall of granite and earth was built around the city. Some parts of this wall still stand. Five gates from the wall, including the South Gate and the East Gate, also remain.

Seoul features a fascinating blend of ancient structures and modern buildings. Several old palaces, preserved in their original form, are now open to the public as museums. They house art objects collected throughout Korea. One of the best-preserved palaces, the Changdok Palace, originates from 1405. It has an adjoining garden called the Secret Garden, which features lovely wooded areas, ponds, and pavilions. Many government buildings stand near the Changdok Palace.

Other historic royal residences in downtown Seoul include the Kyongbok Palace and the Toksu Palace. The Chongmyo Royal Shrine, originally built in 1395, lies southeast of the Changdok Palace. The shrine was built by Yi Songgye, the king who founded Seoul, as a me-

Facts in brief

Population: 10,612,577.
Area: 242 sq. mi. (627 km²).
Climate: *Average temperature*—January, 24 °F (−4 °C); July, 77 °F (25 °C). *Average annual precipitation* (rainfall, melted snow, and other forms of moisture)—49 in. (125 cm).
Government: Special city (same administrative status as a province); under direct supervision of the Office of Prime Minister.
Founded: 1394.



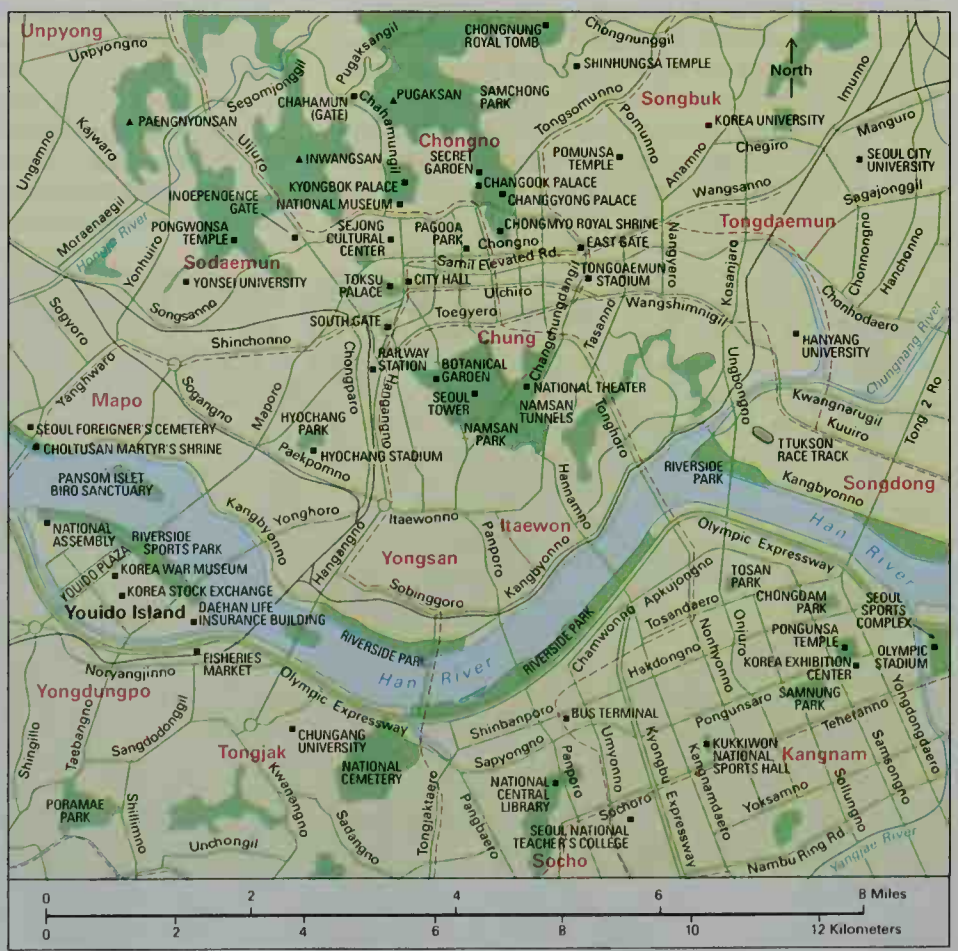
Korea National Tourism Corporation

Seoul's South Gate dates from the city's founding in the late 1300's. Most of the modern buildings rising in the background have been erected since the Korean War ended in 1953.

Seoul

Location of Seoul

Seoul metro area



WORLD BOOK maps

morial to his ancestors.

Modern skyscrapers housing businesses and hotels lie north of the river. Many marketplaces and shops are also in the downtown area. Itaewon is a popular shopping area among tourists. Discount houses concentrated in this section offer a wide selection of items produced in South Korea.

During the 1900's, Seoul expanded to include the plain south of the Han River. About 20 bridges cross the river. Many apartment buildings, factories, office buildings, restaurants, stores, and theaters lie south of the river. Such modern sports facilities as the Seoul Sports Complex, Olympic Stadium, and Olympic Park—used for the 1988 Summer Olympic Games—are also in this area.

South Korea's legislature meets at the National Assembly building on Youido Island in the Han River. South Korea's tallest building, the 63-story Daehan Life Insurance Building, also rises on the island.

Seoul has many theaters that offer a variety of cultural events. The National Theater is the home of the National Ballet Company, the National Drama Company, the National Opera Company, and the National Symphony Company. The theater stands north of the river, in Namsan Park. The Sejong Cultural Center, near the Kyongbok Palace, hosts musical and dance performances.

Seoul has 20 universities. Seoul National University, the best-known institution of higher learning in South Korea, lies at the southern edge of the city. Many other universities are north of the river.

People. Almost all of Seoul's people are Korean and speak the Korean language. The Chinese constitute the largest minority group in Seoul.

Until the late 1900's, most of Seoul's people lived in houses near the Changdok Palace. However, the expansion of the city and the improvement of transportation changed the residential pattern in Seoul. Today, more than half of Seoul's residents live south of the river. Most people live in apartments. Modern high-rise apartment buildings in the newer areas of the city attract many wealthy residents.

The rapid growth of Seoul since the 1960's created some problems common to most metropolitan areas. The population increase has led to a housing shortage, in spite of the construction of new apartment buildings and the development of suburban areas. Traffic congestion persists, and air pollution and water pollution pose serious problems. Seoul's crime rate has also risen.

Economy. Seoul is the center of banking, commerce, and industry in South Korea. Most of the country's banks and businesses have their headquarters in Seoul and employ many of the city's people. Other residents work for the national government or for the city's numerous schools.

Seoul's factories produce a variety of consumer products and employ a large number of workers. Chief products manufactured in the city include automobiles, clothing, electronics, iron and steel, radios, and television sets. Many of these products are exported.

Seoul's people usually shop at huge markets located throughout the city. The biggest markets—Tongdaemun (East Gate) Market and Namdaemun (South Gate) Market—offer all kinds of food and other goods. Different areas in Seoul's market may specialize in one type of goods, such as clothing or antiques. Department stores are also scattered throughout the city.

Railroads, highways, and airlines connect Seoul with cities in the eastern and southern parts of South Korea. Seoul's Kimpo International Airport also handles international flights. The city's subway system provides underground transportation. Cars, buses, and taxis crowd the city's streets. Inchon, about 20 miles (32 kilometers) southwest of the city center, is Seoul's seaport. Inchon also has its own international airport.

About 20 daily newspapers are published in Seoul and distributed throughout South Korea, as are popular monthly and weekly magazines. National TV and radio programs are produced in Seoul.

Government. Seoul is divided into 25 local government units called *gu* (wards or districts) each of which is divided into subdistricts called *dong*. The people of the

Cameramann International, Ltd.

Children's Park, north of the Han River, is one of many parks and recreational areas in Seoul. Visitors gather in the park on Children's Day, *shown here,* a holiday celebrated each spring.

A bustling shopping district in Seoul attracts crowds of customers and passersby. Seoul is South Korea's most densely populated city.

© Porterfield/Chickering, Photo Researchers

city elect the chiefs of the 25 districts, the mayor, and a City Assembly of 133 members, which makes the city's laws.

History. Archaeological remains indicate that people lived on the northern shore of the Han River near present-day Seoul thousands of years ago. In 1067, King Munjong of the Koryo *dynasty* (family of rulers) designated the town as Namgyong (Southern Capital). It was later known by the name Hanyang.

In 1392, General Yi Songgye overthrew the Koryo dynasty and seized the throne. Yi founded the Yi dynasty, who became rulers of what is now Korea. He made Hanyang the capital of his kingdom. The construction of Seoul began in 1394. In 1396, about 200,000 workers were brought to Seoul to build the wall around the city.

Various Yi kings built palaces and other buildings in Seoul, and the city prospered. But an invasion by the Japanese in 1592 completely destroyed the city. In 1636, Chinese invaders ravaged Seoul. However, the city was rebuilt after these invasions, and its population increased.

Many important changes took place in Seoul beginning in the late 1800's. Telegraph service began in 1885, with lines between Seoul and Inchon. Schools patterned after those in the West opened in 1886. Missionaries also established schools around that time.

In addition, Seoul's first modern newspaper was published in 1896. Electric streetcars began to operate in the city in 1899, and in 1902, the first long-distance telephone line in Korea linked Seoul and Inchon.

Japan exerted increasingly strong political and military influence in the area during the late 1800's and the early 1900's. The Yi dynasty continued to rule Korea until 1910, when Japan annexed it as a colony. Seoul became the seat of the Japanese governor general. The Japanese put up many modern buildings throughout the city. These buildings included the Seoul Railway Station and the Governor General's Building, a huge and imposing stone structure that symbolized Japanese power.

The Japanese ruled Korea until 1945, when Japan was defeated in World War II. Korea then was divided. The armed forces of the Soviet Union ran the northern half. The United States military ruled the southern half of Korea, with headquarters at the Governor General's Building.

In 1948, the two separate governments of North Korea and South Korea were formed. The South Korean government also used the Governor General's Building as its headquarters. The building is now the National Museum.

The Korean War began in 1950, when North Korean troops invaded South Korea in an attempt to unify the country under Communist rule. Seoul fell to the North Korean Army in June 1950. South Korean and U.S. soldiers recovered the city in September, but they lost it to the Chinese and North Korean armies in January 1951. The South Korean Army regained control of Seoul a few months later. But repeated battles inside the city had destroyed many of the buildings. The war ended in 1953. The people of Seoul rebuilt the city.

Park Chung Hee controlled the South Korean government from 1961 until his death in 1979. Under Park, South Korea experienced tremendous economic growth. Park's economic programs called for the development of industries in various parts of the country, including Seoul. Until that time, Seoul had no major industry. Many new factories were built in Seoul during the 1960's and 1970's, and thousands of people moved there from rural areas to find work. Housing construction also boomed. New stores and restaurants opened, and various corporations built office buildings.

When the industrial and residential areas of Seoul became too crowded, construction of new factories and houses spread south of the Han River. The 1988 Summer Olympic Games were held in Seoul. New sports facilities, including a stadium that seats about 100,000 people, were built for the games. Chong-Sik Lee

See also Inchon; Korea (pictures).

Separation of powers. See United States, Government of the (Separation of powers); Government (The organization of government).

Separatists. See Pilgrims; Puritans.

Separator. See Butter (History).

Sepiolite. See Meerschaum.

Sepoy Rebellion. See Indian Rebellion.

September is the ninth month of the year, according to the Gregorian calendar, which is used in most of the world today. It was the seventh month of the early Roman calendar, and its name comes from the Latin word *septem*, meaning *seven*. September became the ninth month when the ancient Romans moved the start of the year from March 1 to January 1. September has had 30 days since the time of the Roman emperor Augustus.

The autumnal equinox in the Northern Hemisphere (vernal equinox in the Southern Hemisphere) occurs on September 22 or 23. On this day, the sun shines directly on the equator, and the lengths of day and night are nearly equal. Japanese Buddhists observe Higan on the equinox. During this time people honor their ancestors, often visiting their graves.

September has long been a month for harvesting crops and giving thanks. Today, many cultures still hold September harvest celebrations. Onam is a harvest festival in India. People in China and other countries of East and Southeast Asia celebrate the Mid-Autumn Festival or Moon Festival. On the night of the full moon, families often gather to watch the moon and have a feast or picnic that includes round "moon cakes." Ghana's Yam Festival marks both the harvest and the New Year.

Some religious holidays fall in September. Rosh Ha-Shanah, the Jewish New Year, usually begins in this month and lasts for two days. Jews observe Rosh Ha-Shanah as a solemn time of prayer and asking for forgiveness. Challah bread and apples dipped in honey are special Rosh Ha-Shanah foods. Other Jewish holidays including Tzom Gedaliah, a fast day; Yom Kippur, the Day of Atonement; Sukkot, the Feast of the Tabernacles; and

Important September events

1 Canadian provinces of Alberta and Saskatchewan established, 1905.
—German troops invaded Poland, starting World War II in Europe, 1939.
2 Great fire of London began, 1666.
—U.S. Department of the Treasury established, 1789.
—Queen Liliuokalani of Hawaii born 1838.
—V-J Day; Japan surrendered in World War II, 1945.
3 United Kingdom signed Treaty of Paris, ending the Revolutionary War in America, 1783.
—Louis H. Sullivan, American architect, born 1856.
—First Labor Day celebrated in the United States, 1894.
4 François René de Chateaubriand, French author, born 1768.
—Marcus Whitman, American missionary, born 1802.
—Daniel H. Burnham, American architect, born 1846.
—Transcontinental television service began with a telecast of the Japanese peace conference, 1951.
5 First Continental Congress met in Philadelphia, 1774.
—Jesse James, American outlaw, born 1847.
6 Massachusetts Bay Colony established, 1628.
—Marquis de Lafayette, French statesman, born 1757.
—John Dalton, English scientist, born 1766.
—Jane Addams, founder of Hull House, born 1860.
—U.S. President McKinley shot by an assassin, 1901.
—Swaziland received full independence in 1968.
7 Queen Elizabeth I of England, born 1533.
—Brazil declared independence in 1822.
—American financier J. P. Morgan, Jr., born 1867.
—Blitz of London in World War II began, 1940.
8 First permanent white settlement in what is now the United States founded in St. Augustine, Florida, 1565.
—Antonín Dvořak, Czech composer, born 1841.
—Robert A. Taft, American senator from Ohio, born 1889.
—Italy surrendered in World War II, 1943.
9 Cardinal Richelieu, French statesman, born 1585.
—Luigi Galvani, Italian anatomist, born 1737.
—William Bligh, British sea captain of the *Bounty*, born 1754.
—California became the 31st U.S. state, 1850.
10 Oliver Hazard Perry defeated the British in the Battle of Lake Erie during the War of 1812, 1813.
—Elias Howe patented his sewing machine, 1846.
—Arthur H. Compton, American physicist, born 1892.
11 Battle of Brandywine in the American Revolution, 1777.
—William Sydney Porter, American short-story writer who used the pseudonym O. Henry, born 1862.
—Chile's military leaders overthrow the elected government of Salvador Allende, 1973.
—Terrorists crashed jetliners into the World Trade Center in New York City and into the Pentagon Building near Washington, D.C., 2001.
12 Henry Hudson entered the Hudson River, 1609.
—H. L. Mencken, American editor, born 1880.
—Soviets launched first rocket to the moon, 1959.
—Emperor Haile Selassie I of Ethiopia overthrown after 44 years as that country's ruler, 1974.
13 Walter Reed, American surgeon, born 1851.
—John J. Pershing, American general, born 1860.
—Arnold Schoenberg, Austrian composer, born 1874.
14 The United Kingdom and its American colonies adopted the Gregorian calendar, 1752.
—Alexander von Humboldt, German scientist and geographer, born 1769.
—Francis Scott Key wrote "The Star-Spangled Banner" during the attack on Fort McHenry in War of 1812, 1814.
15 Mexican Independence Days begin.
—Respect for the Aged Day, Japan.
—James Fenimore Cooper, American novelist, born 1789.
—Most of Central America achieved independence in 1821.
—Porfirio Díaz, president of Mexico, born 1830.
—William Howard Taft, 27th U.S. president, born 1857.
—British Army became the first to use military tanks, 1916.

Sept. birthstone—sapphire

Sept. flower—morning glory

Sept. 1—start of World War II

Sept. 7—Queen Elizabeth I of England born

Simhat Torah, a day of rejoicing, are all celebrated in September or early October. Hindus begin the 10-day celebration of Durga Puja, or the Festival of the Divine Mother, in September.

Various other celebrations take place in September. Labor Day falls on the first Monday of the month in Canada and the United States. Mexicans celebrate their independence on September 15 and 16. National Hispanic Heritage Month begins on September 15 in the United States. Many Chinese celebrate the birth of Confucius in about 551 B.C. on September 28.

September's flowers are the morning-glory and the aster. Its gem is the sapphire. Carole S. Angell

Quotations

By all these lovely tokens
September days are here,
With summer's best of weather
And autumn's best of cheer.

Helen Hunt Jackson

The morrow was a bright September morn;
The earth was beautiful as if newborn;
There was nameless splendor everywhere,
That wild exhilaration in the air,
Which makes the passers in the city street
Congratulate each other as they meet.

Henry Wadsworth Longfellow

Related articles in *World Book* include:

Calendar
Harvest moon
Labor Day
Morning-glory
Rosh Ha-Shanah
Sapphire
Sukkot
Yom Kippur

Important September events

16 Pilgrims sailed from England in the *Mayflower,* 1620.
—Selective Service Act passed by U.S. Congress, 1940.
17 Citizenship Day, United States.
—Friedrich Wilhelm von Steuben, German American general in the American Revolution, born 1730.
—Constitution of the United States signed, 1787.
18 Samuel Johnson, English author and dictionary maker, born 1709.
—Quebec surrendered to the British, 1759.
—Washington laid cornerstone of the U.S. Capitol, 1793.
—Chile gained an independent government, 1810.
—Jean Foucault, French physicist, born 1819.
—John George Diefenbaker, prime minister of Canada, born 1895.
—Japanese forces invaded Manchuria, 1931.
19 Edward, the "Black Prince" of England, won the Battle of Poitiers in the Hundred Years' War, 1356.
—First Battle of Freeman's Farm in the American Revolution began, 1777.
—U.S. President George Washington's Farewell Address published, 1796.
—Lajos Kossuth, Hungarian patriot, born 1802.
—Battle of Chickamauga, American Civil War, began 1863.
—President James A. Garfield dies, 1881.
20 Sister Elizabeth Kenny, Australian nurse, born 1886.
21 Girolamo Savonarola, Italian reformer, born 1452.
—Great hurricane swept the U.S. Atlantic Coast, 1938.
—Malta became an independent constitutional monarchy, 1964.
22 Earl of Chesterfield, English statesman and author, born 1694.
—Nathan Hale, American patriot, put to death by British, 1776.
—Michael Faraday, English scientist, born 1791.
—President Abraham Lincoln issued preliminary Emancipation Proclamation, 1862.
—French Sudan gained complete independence as the Republic of Mali in 1960.
23 Augustus, first Roman emperor, born 63 B.C.
—Thomas Osborne, American prison reformer, born 1859.
24 Horace Walpole, English author, born 1717.
—John Marshall, U.S. chief justice, born 1755.
—F. Scott Fitzgerald, American author, born 1896.
25 Columbus sailed on second voyage to America, 1493.
—Spanish explorer Vasco Núñez de Balboa sighted the Pacific Ocean, 1513.
—*Publick Occurrences,* first American newspaper, appeared in Boston, 1690.
—Amendment 12 to the U.S. Constitution, changing details of presidential elections, proclaimed in 1804.
—William Faulkner, American novelist, born 1897.
—Dimitri Shostakovich, Russian composer, born 1906.
26 T. S. Eliot, American-born poet, born 1888.
—George Gershwin, American composer, born 1898.
27 Samuel Adams, American patriot, born 1722.
—George Cruikshank, English caricaturist, born 1792.
—Thomas Nast, American cartoonist, born 1840.
—Louis Botha, first South African prime minister, born 1862.
—Germany, Italy, and Japan signed a mutual military aid pact, 1940.
28 William the Conqueror landed in England, 1066.
—Georges Clemenceau, French statesman, born 1841.
29 Robert Clive, British soldier, born 1725.
—Horatio Nelson, British naval hero, born 1758.
—Henry H. Richardson, American architect, born 1838.
—Miguel de Unamuno, Spanish philosopher and author, born 1864.
—Enrico Fermi, Italian American nuclear physicist, born 1901.
30 Pompey, Roman general, born 106 B.C.
—Bechuanaland Protectorate gained independence as the Republic of Botswana in 1966.

WORLD BOOK illustrations by Mike Hagel

Sept. 15-16—Mexican Independence Days

Sept. 16—*Mayflower* sailed from England

Sept. 17—U.S. Constitution signed

Sept. 23—Naval victory by John Paul Jones

AP/Wide World

After the terrorist attack on the World Trade Center on Sept 11, 2001, rescue workers struggled to find survivors in the smoking ruins of the collapsed twin towers in New York City.

September 11 terrorist attacks were the worst acts of terrorism ever carried out against the United States. On Tuesday, Sept. 11, 2001, terrorists in hijacked commercial jetliners slammed into the two towers of the World Trade Center in New York City and into the Pentagon Building near Washington, D.C. Another hijacked jet crashed in rural Pennsylvania. About 3,000 people were killed, and the World Trade Center towers and part of the Pentagon were destroyed. United States officials soon concluded that the Saudi millionaire Osama bin Laden and his *al-Qa'ida* (also spelled *al-Qaeda*) terrorist organization had been behind the attacks.

United States President George W. Bush called the attacks "acts of war" and launched a "war on terrorism." This war led to the overthrow of Afghanistan's rulers, the Taliban, who had sheltered bin Laden since 1996.

The attacks

The terrorist attacks involved four hijacked airplanes. The planes left airports on the East Coast within about 40 minutes of one another on the morning of September 11. The aircraft were headed across the country to California and, as a result, were carrying thousands of gallons of fuel. Among the people aboard the four planes were 19 al-Qa'ida terrorists secretly carrying knives and box-cutters, tools with sharp blades. Shortly after departure, the terrorists took over the planes. At least some of them had had pilot training, investigators later learned, and they probably flew the planes.

The World Trade Center. American Airlines Flight 11, bound for Los Angeles, took off from Boston's Logan International Airport at about 8 a.m. (All times of day in this article are in Eastern Daylight Time.) There were 92 people aboard. Soon afterward, at a nearby gate, United Airlines Flight 175 left for Los Angeles with 65 people.

At about 8:45 a.m., Flight 11 crashed into the north tower of the World Trade Center. Less than 20 minutes later, Flight 175 hit the south tower. The 110-story twin towers ranked among the world's tallest skyscrapers and were the most famous part of the World Trade Center, a complex of seven buildings. The complex contained offices of a number of U.S. government agencies and many businesses and organizations involved in finance and international trade. About 50,000 people worked in the complex.

Flames and smoke engulfed the towers after the fuel-laden planes crashed into them. People raced to escape the buildings and the area. Police, fire, and medical personnel rushed to the site. About an hour after being struck, the south tower, weakened by fire, collapsed. About a half-hour later, the north tower collapsed. Other buildings in the area were also destroyed or heavily damaged. The attacks left about 2,800 people dead or missing, including 157 dead on the two hijacked planes.

The Pentagon. American Flight 77 left Dulles International Airport in Virginia at about 8:20 a.m. on September 11, headed for Los Angeles. It carried 58 people. At about 9:40 a.m., Flight 77 crashed into the west side of the Pentagon Building, the nation's military headquarters near Washington, D.C. A section of the building collapsed shortly afterward, leaving 189 people dead or missing, including the people on the hijacked plane.

Pennsylvania. United Flight 93 left Newark International Airport at 8:01 a.m., headed for San Francisco. There were 44 people on the plane. Shortly after 10 a.m., Flight 93 crashed in a field in Somerset County in southwestern Pennsylvania. All aboard were killed.

Reports of what occurred on Flight 93 were drawn from phone calls passengers made before the crash. Several passengers, aware of the other attacks, said they would try to overcome the hijackers. The intended target of the terrorists on Flight 93 is not known.

The aftermath

The immediate reactions to the terrorist attacks included evacuating the White House and offices of the federal government and halting all nonmilitary air traffic over the nation. The major U.S. stock exchanges stopped trading, and many businesses and public landmarks closed early and sent employees home.

In a televised speech Tuesday evening, President Bush said, "Today, our nation saw evil." He said, "These acts of mass murder were intended to frighten our nation into chaos and retreat. But they have failed; our country is strong."

The U.S. government launched a massive investigation to find those responsible for the attacks. Government leaders also worked to increase national security and to strengthen the nation's weakened economy.

Increased national security. In mid-September, President Bush announced the creation of a federal Office of Homeland Security to improve the nation's de-

fense against future terrorist attacks. Bush appointed Pennsylvania Governor Thomas J. Ridge to head the office. Ridge resigned as governor and took responsibility for overseeing and coordinating national efforts to protect against and respond to attacks of terrorism.

In the weeks following the September 11 attacks, several U.S. business and government offices received mail that contained anthrax bacteria. Anthrax is an infectious disease that can be fatal if not treated promptly. Five people died from exposure to the bacteria, and fear of anthrax spread across the country. Investigators initially looked for evidence linking the terrorists to the anthrax mailings but found no connection. They then came to believe the source was within the United States.

In October, the U.S. Congress passed an antiterrorism bill giving the government expanded investigative powers against suspected terrorists. For example, the law allows greater scope in conducting electronic surveillance and in detaining immigrants without charges. Some people criticized the act, fearing that such measures would limit civil liberties. The law also aims to help prevent funds from reaching terrorists. It permits the Department of the Treasury to require banks to make greater efforts to determine the sources of large overseas private banking accounts.

After the attacks, Bush also called for increased aviation security. In November, Congress passed legislation that gave the federal government a central role in security measures in airports. The legislation required that all workers who screen travelers and baggage in airports be federal employees. Before then, the airlines had hired the screeners. The bill specified that the transition to federal employees be completed within a year.

War on terrorism. United States leaders became convinced that the September 11 attacks were the work of the extremist Muslim leader Osama bin Laden and his al-Qa`ida terrorist network. Bin Laden and al-Qa`ida were known to strongly oppose United States policies in the Middle East, particularly U.S. support for Israel and the presence of U.S. troops in Saudi Arabia. Bin Laden's headquarters and terrorist training camps were in Afghanistan. Bush called upon the Taliban, the rulers of Afghanistan, to turn over bin Laden and close down the training camps. The Taliban refused. Meanwhile, Bush worked to form a coalition of countries to wage what he called a "war on terrorism." Bush said the war would include such measures as tightened security, efforts to cut off funds to terrorists, and military action against terrorists and the countries that harbored them.

On October 7, the United States and its allies launched a military campaign in Afghanistan against the Taliban and al-Qa`ida. The campaign included massive air strikes in support of the Northern Alliance and other Afghan rebel groups who opposed the Taliban. This support enabled the rebels to overthrow the Taliban in December. The United Nations brought together representatives of Afghanistan's leading factions to discuss the formation of a new national government. In early December, the members of the group agreed on a plan for a new government.

Weakened economy. In November 2001, economic data showed the U.S. economy had been in a recession since March. After the events of September 11, unemployment increased and the recession worsened. Among companies hit hardest by the economic slowdown were many airlines. Some airlines faced bankruptcy. After the attacks, their insurance costs greatly increased, and they had to undertake costly overhauls of their security systems. At the same time, their incomes dropped sharply because many people were afraid to fly. Congress passed a $15-billion package of cash and loan guarantees to support the failing airlines.

Moving forward. New York City, which had suffered the greatest loss of life and physical damage, faced severe challenges. After the attacks, Mayor Rudolph W. Giuliani helped guide the city through a difficult recovery period. He was widely praised for his leadership. Workers toiled around the clock to clean up the mountain of twisted steel and other debris from *ground zero,* the site of the Trade Center attacks. At the Pentagon, the ruins of the shattered section were cleared away and rebuilding began. Barbara Lanctot

See also **Bin Laden, Osama; Qa`ida, Al-; Taliban; Terrorism; World Trade Center.**

AP/Wide World

The Pentagon Building, the military headquarters of the United States, was one of the targets of terrorists on Sept 11, 2001. A section of the Pentagon collapsed after terrorists slammed a hijacked jetliner into the building.

Septic sore throat. See Strep throat.
Septicemia. See Blood poisoning.
Septillion, in the United States and France, is a number followed by 24 zeros. One septillion is written 1,000,000,000,000,000,000,000,000. In the United Kingdom and Germany, it is a number followed by 42 zeros. See also Decimal system (Larger numbers).
Septuagint, *SEHP chu uh jihnt* or *SEHP tyu uh jihnt,* is the name of the oldest known written translation of the Hebrew Bible, called the Old Testament in Christianity. The Septuagint is a translation from Hebrew into Greek. The name *septuagint* comes from a Latin word meaning *seventy.*

According to legend, 72 Jewish scholars translated the first five books of the Hebrew Bible, known as the *Pentateuch,* in 72 days. The process began in Alexandria, Egypt, in the 200's B.C. and eventually included other sections of the Bible. The translation actually took about 200 years to complete. The Septuagint has certain characteristics of style, vocabulary, and order that indicate its translators based some parts on a Hebrew text that differed from the main sources for the Hebrew Bible used today. Carol L. Meyers

Septum. See Heart (The structure of the heart; Abnormal openings in the heart); Nose.
Sequoia, *sih KWOY uh,* is a tree that ranks among the largest and oldest living things on earth. Millions of years ago these trees grew in large forests throughout much of the world. There were many different kinds. But only two kinds of the true sequoias remain, along with a Chinese tree that is closely related to them. Both kinds of true sequoias, the redwood and the giant sequoia, are found chiefly in California. The name *sequoia* comes from the name of a Cherokee Indian who invented a written alphabet for his tribe.

The redwood

Redwoods, also called *coast* and *California redwoods,* grow near the Pacific Coast from central California into the southern part of Oregon. The redwood trees thrive there in the relatively warm coastal fog belt.

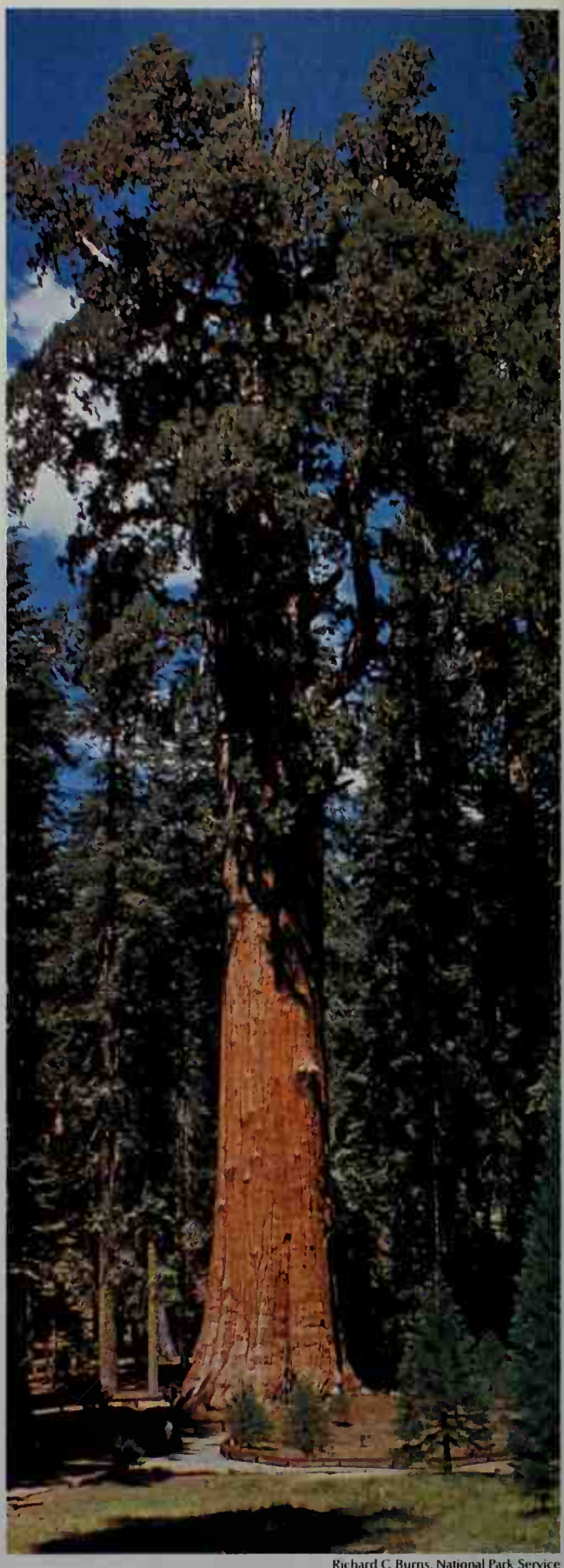
Redwoods are the tallest living trees. They grow over 300 feet (91 meters) high, or about as high as a 30-story building. Their lowest branches may be more than 150 feet (46 meters) from the ground. Many trunks are over 10 feet (3 meters) in diameter. The tree's flat, evergreen leaves are about $\frac{1}{2}$ inch (15 millimeters) long.

The redwood's bark is from 6 to 12 inches (15 to 30 centimeters) thick and is deeply furrowed. It ranges in color from red-brown to cinnamon-brown. The wood of the tree is a light clear red. When it is exposed to the weather, it turns dark red. It is durable, and is important in the lumbering industry. A single tree may give as much as 480,000 board feet (1,130 cubic meters) of lumber. See Redwood.

The giant sequoia

The giant sequoia is sometimes called the *big tree* or *Sierra redwood.* It grows only on the western slopes of the Sierra Nevada mountains of California at elevations from 5,000 to 7,800 feet (1,500 to 2,380 meters).

The giant sequoias were once distributed over most of the Northern Hemisphere. They now grow in only about 70 groves.



Richard C. Burns, National Park Service

The world's largest tree, according to volume of wood, is the General Sherman Tree, *shown here,* in Sequoia National Park in California. This giant sequoia ranks as one of the oldest living things on the earth. It is between 2,200 and 2,500 years old.

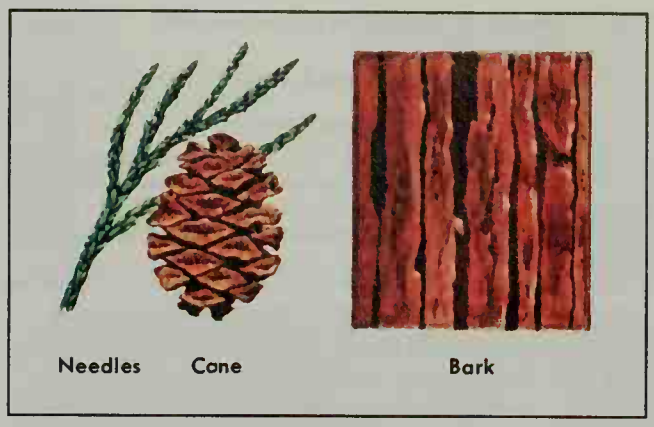
Size. Giant sequoias do not grow as tall as redwoods. But their trunks are much larger. Several of them are about 100 feet (30 meters) around at the base. The diameter of the widest trunk is 37.3 feet (11.4 meters). The world's largest tree in volume of wood is the General Sherman Tree, in Sequoia National Park. It is 275 feet (83.8 meters) high, and the base of its trunk has a circumference of 103 feet (31.4 meters). It has been estimated that the General Sherman tree would yield over 600,000 board feet (1,400 cubic meters) of lumber. Another of the largest giant sequoias is the Grizzly Giant in the Mariposa Grove in Yosemite National Park. The wood of giant sequoias is extremely brittle and is therefore of little use in lumbering.

Age. Scientists can tell much about a tree's history and age by looking at the *growth rings.* Each year the tree forms a new layer of wood just inside the bark. The number of rings that make up the trunk show how old the tree is. Sometimes the climate during the year is also shown by the growth ring. Wide rings show that the growing season was good, while narrow rings show that the season was poor. Sometimes lack of rain will cause a poor growing season. See Tree (illustration: How a tree reveals its history).

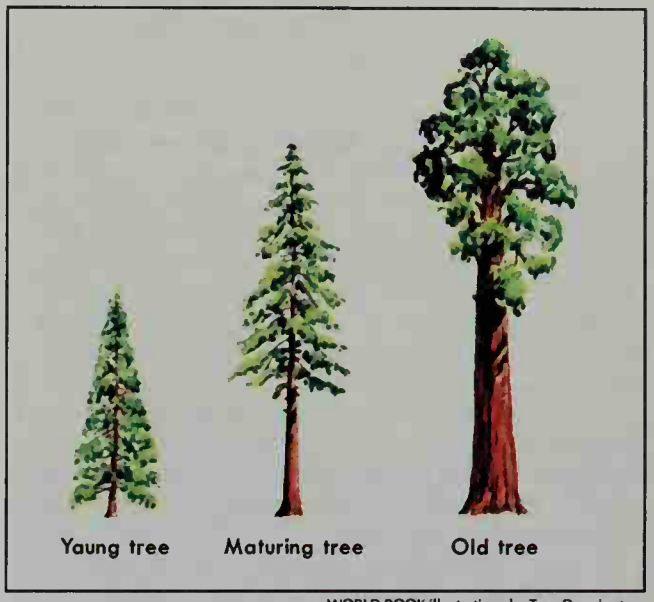
Many of the giant sequoias are several thousand years old. It has been estimated that the General Sherman Tree is between 2,200 and 2,500 years old. Before a law was passed that protected sequoias from being cut, one of the oldest and largest of them was chopped down. The growth ring at the center of this giant sequoia dated back to 1305 B.C. Therefore, it was more than a thousand years old at the time of the birth of Christ.

Habits. The giant sequoia is an evergreen. Its pointed needles are $\frac{1}{4}$ to $\frac{1}{2}$ inch (6 to 13 millimeters) long and radiate in all directions from the twig. They lie more or less parallel to the twig, except for the tip, which is sharp and stands out. The cone is woody and oval-shaped. It grows about 2 to 3 inches (5 to 8 centimeters) long. Each cone contains numerous small seeds, which take two years to mature. The seeds of the giant sequoia are only $\frac{1}{4}$ inch (6 millimeters) long. It would take about 50,000 of them to weigh 1 pound (0.5 kilogram).

The giant sequoias are very durable. None of these trees has been known to die from old age, disease, or insect attack. Their extremely thick bark protects them from injury by fire. However, lightning has destroyed the tops of most of the largest sequoia trees.



Giant sequoias have small, pointed needles and oval-shaped cones. The bark measures up to 2 feet (61 centimeters) thick on older trees. It helps protect sequoias from fire and insects.



WORLD BOOK illustrations by Tom Dunnington

A young sequoia, *left,* has a conelike shape, and its branches reach the ground. The lower branches later drop off, *center,* but the cone-shaped crown remains. Most older sequoias lose their tops to lightning and have a rounded crown, *right.*

The dawn redwood

The dawn redwood is the closest known relative of the sequoias. Scientists once believed that the dawn redwood had become extinct millions of years ago. They studied the tree and knew about it only from fossil remains. But in 1941, a Chinese forester, Tsou Kan, discovered a large tree growing in a hidden valley of central China. In 1946, two Chinese botanists, Hsen-Hsu Hu and Wan-Chun Cheng, identified this tree as the dawn redwood. Thus it was discovered that a tree, believed to have become extinct 20 million years before, was still growing in several areas.

Living dawn redwoods have since been found in Sichuan and Hubei provinces of China. Fossils show that the dawn redwood once grew in North America as far south as California, and in Greenland, Siberia, and Japan.

Unlike the true sequoias, which are evergreens, the dawn redwood is a *deciduous* tree (see Deciduous tree). Each fall it sheds its leaves and new ones appear again in the spring.

Like the other sequoias, dawn redwoods grow readily from seeds. Scientists brought seedling trees from China and planted them in the Eastern United States and the Pacific Northwest. Most of the seedlings survived, and have grown.

Protection of sequoias

Most of the large sequoias are under protection of the United States government. Only 8 per cent of the trees that are more than 10 feet (3 meters) in diameter are privately owned. Great care is taken to avoid any injury to the trees.

Scientific classification. Sequoias belong to the taxodium family, Taxodiaceae. The redwood is *Sequoia sempervirens.* The giant sequoia is classified as *Sequoiadendron giganteum.* The

dawn redwood is *Metasequoia glyptostroboides.*

Linda B. Brubaker

See also Conifer; Redwood; Tree (picture).

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Sequoia National Park, *sih KWOY uh,* in the United States, is the home of one of the finest stands of giant sequoia trees. In this park are thousands of these trees, several hundred of which are more than 10 feet (3 meters) in diameter. The world's largest tree in volume of wood is a sequoia known as the General Sherman Tree. The tree is 275 feet (83.8 meters) high and has a circumference of 103 feet (31.4 meters). The diameter of its trunk at the base, 36.5 feet (11.13 meters), is wider than most streets. The giant sequoia is between 2,200 and 2,500 years old.

The park is on the western slopes of the Sierra Nevada in central California. Most of it is mountain wilderness. There is a difference in altitude of over 2 miles (3.2 kilometers) from the park's lowest point to its highest. From the top of Mount Whitney (14,495 feet, or 4,418 meters), one of the highest peaks in the United States, the visitor can look 100 miles (160 kilometers) east to mountains around Death Valley. For Sequoia National Park's area, see National Park System (table: National parks).

There are over 900 miles (1,400 kilometers) of trails in the park. Mountain streams and lakes offer fine trout fishing. Kern River Canyon, Crystal Cave, and the rugged crags of the Sierra attract thousands of visitors. The park is popular for winter sports.

Sequoia National Park was established on Sept. 25, 1890, and was the second national park created. Yellowstone National Park, the oldest, was set aside 18 years earlier. It was largely through the efforts of George W. Stewart that the giant sequoia trees were saved from the lumber mills. Kings Canyon National Park adjoins Sequoia National Park on the north. The National Park Service administers both of these parks.

Critically reviewed by the National Park Service

See also Kings Canyon National Park.

Sequoyah, *sih KWOY uh* (1775?-1843), a Cherokee Indian, is best known for inventing a system for writing the Cherokee language. His name is often spelled *Sequoya.* The giant sequoia tree and Sequoia National Park in California were named after him, using the Latin spelling of his name.

Many details about Sequoyah's life are unknown or uncertain. He was born in Loudon County, Tennessee. Most historians believe his father was white and his mother was Cherokee or part-Cherokee. Sequoyah spoke little or no English. He was married and had several children.

As an adult, Sequoyah became interested in the written language of whites. At that time, there was no written form of the Cherokee language. In 1809, Sequoyah began to develop a system for writing Cherokee words. He created a set of 86 symbols to represent each of the speech sounds used in spoken Cherokee. He perfected the system in 1821.

Granger Collection

Sequoyah invented a system of writing suitable to the Cherokee language. Most Cherokee learned the system quickly.

Nearly all of the Cherokee could learn Sequoyah's writing system in a short period of time. The Cherokee used it to publish books and newspapers in their own language.

Sequoyah became active for a time in Cherokee political affairs. In 1828, he moved to the part of the Indian Territory that is now Oklahoma to join the western Cherokee. When the eastern Cherokee were forced to migrate west in 1838, Sequoyah worked to reestablish unity among the two groups. Later, he traveled to Mexico seeking a lost group of Cherokee. He died there in 1843.

Gary E. Moulton

Serajevo. See Sarajevo.

Serapis, *suh RAY pihs,* was a god who suddenly became popular in Egypt in the 300's B.C. The Ptolemaic rulers of Egypt, beginning with Ptolemy I in 323 B.C., built an elaborate temple for Serapis, and they actively promoted the cult of Serapis throughout the Mediterranean world.

Serapis combined Egyptian and Greek characteristics. In Alexandria, he was portrayed seated on a throne in the pose of a royal figure like Zeus, the king of the Greek gods. Serapis was god of the underworld, associated with Isis, a popular Egyptian goddess. In addition, he provided fertility as the lord of the Nile River. He protected seafarers, inspired oracles, healed the ill, and reigned over the universe like Zeus.

Serapis derived many of his Egyptian characteristics from the cult of Osiris-Apis at Memphis. The name *Serapis* may be a combination of Osiris and Apis. Osiris, the husband of Isis, was a fertility god and god of the underworld. Apis was the earthly form of Osiris in the figure of a bull.

Orval Wintermute

Serbia, *SUR bee uh,* is one of the two republics of Yugoslavia. Montenegro is the other. Serbia covers about 34,116 square miles (88,361 square kilometers) in southeastern Europe. It includes the provinces of Kosovo and Vojvodina. Serbia has about 10 million people. Belgrade, its largest city, is the capital of Yugoslavia.

In 1918, Serbia became part of the Kingdom of the Serbs, Croats, and Slovenes, later renamed Yugoslavia. In 1946, Yugoslavia became a federal state made up of six republics, the largest of which was Serbia. In 1991 and 1992, four of the republics—Slovenia, Croatia, Macedonia, and Bosnia-Herzegovina—declared their independence. In April 1992, Serbia and Montenegro formed a new, smaller Federal Republic of Yugoslavia.

In 1998, fighting began between Serbian forces and ethnic Albanians in Kosovo. Serbian troops withdrew in 1999. In 2002, the leaders of Serbia and Montenegro announced plans to rename the country Serbia and Montenegro. See the *History* section of this article for details.

Government. A president heads the government of Serbia. Voters elect the president to a four-year term. This official may not serve more than two terms. A one-house National Assembly is Serbia's legislative body. Its 250 members are elected by the people to four-year terms. All citizens who are 18 years and older may vote.

In 1990, the Assembly approved a new constitution, which promised freedom of travel, press, and religion, and other civil rights. During the reign of Slobodan Milošević in the 1990's, the government restricted many of these rights. Serbia's major political parties are the Socialist Party of Serbia, the Democratic Movement of Serbia, and the Serbian Radical Party.

The Court of the Republic of Serbia is Serbia's highest court. The Assembly appoints judges for life.

People. In the area excluding Kosovo and Vojvodina—sometimes called Serbia proper—Serbs make up about 85 percent of the population. About 55 percent of Vojvodina's population are Serbs, and nearly 20 percent are Hungarians. The province also includes large numbers of Croats, Montenegrins, Romanians, and Slovaks. In Kosovo, before the fighting that took place in the late 1990's, about 90 percent of the people were Albanians, and the rest were mainly Serbs.

Serbo-Croatian is the official language of Serbia. Serbo-Croatian exists in two main forms, Serbian and Croatian. Serbian, which is spoken by the Serbs, traditionally uses the Cyrillic alphabet, the same system of writing used in Russian. Croatian, which is spoken by the Croats, uses the Roman alphabet. However, many Serbian books were published in the Roman alphabet during Josip Broz Tito's rule of Yugoslavia from 1945 to 1980. Tito sought to unify the various nationality groups in Yugoslavia by promoting use of a single alphabet.

About half the people of Serbia live in cities. Most city dwellers live in older brick houses or apartment buildings. Typical suburban housing consists of high-rise apartment buildings made of concrete. Many rural families live in brick, stone, or wooden houses.

Serbian cooking reflects both central European and Turkish influences. *Ćevapćići,* which consists of grilled meatballs served with raw onions on bread, is a Serbian specialty. *Ajvar* is a relish made of roasted red peppers. A favorite snack in Serbia is *burek,* a pastry layered with cheese, meat, or jam. Typical Serbian beverages include thick, sweet Turkish coffee and plum brandy.

WORLD BOOK maps

Serbia is one of the two republics of Yugoslavia. The other is Montenegro. Serbia lies on the Balkan Peninsula of Europe.

Serbians enjoy many sports, particularly soccer. Basketball is also popular, and almost every town or village in Serbia has its own basketball team.

The traditional religion of the Serbs is Serbian Orthodoxy. Some Serbs are members of the Seventh-day Adventist Church. Hungarians and Slovaks typically belong to such ethnic churches as the Hungarian Evangelical Lutheran Church or the Slovak Evangelical Christian Church. Most Albanians in Kosovo are Muslims.

Children in Serbia must complete at least 8 years of elementary school. However, most children attend school for 12 years. Serbia has universities in Belgrade, Novi Sad, and Priština.

Most adults in Serbia's urban areas are well-educated. However, in rural Serbia, especially among Albanian Muslims, families have traditionally kept girls out of

© Tom Sobolik, Black Star

Belgrade, Serbia, is the capital and largest city of Yugoslavia. It lies in northern Serbia. The city's downtown section includes a pedestrian mall, *shown here.*

school to work around the house or on the farm. This practice has kept many rural women in domestic roles.

Serbian folk music is played mainly on the accordion. The violin and the *tamboura,* an instrument resembling a lute, are also used to accompany folk dances in certain parts of Serbia. The best-known traditional dance among the Serbs is the *kolo,* which is performed in a circle. Since the early 1980's, a new, sometimes extreme, pride in Serbian culture has swept the republic. This movement has sparked an interest in Serbian writers of the 1900's, such as Matija Bečkovic, Miloš Crnjanski, Dobrica Ćosić, and Vuk Drašković.

Land and climate. The Pannonian Plains lie in northern Serbia. The region is mostly flat, with some low hills. The rest of Serbia is hilly or mountainous.

A number of rivers flow through Serbia. They include the Danube, one of Europe's longest waterways. The Danube flows southeast to the Black Sea. The Morava River runs north through the hills of southern and central Serbia and then empties into the Danube. The Sava River flows east, emptying into the Danube at Belgrade.

The Pannonian Plains have cold winters with a freezing wind called a *košava.* Summers are dry and hot, with temperatures often rising to about 100 °F (38 °C). In Belgrade, on the edge of the Pannonian Plains, the average January temperature is 32 °F (0 °C). The average July temperature is 73 °F (23 °C). The rest of Serbia has bitterly cold winters with much snow. Heavy rains fall in early summer. Summers are warm in the mountain valleys but cool at higher elevations.

Economy. After World War II (1939-1945), the economies of Serbia proper and Vojvodina grew steadily until the late 1970's, when they began to decline. In Kosovo, the standard of living began at a much lower point and has continued to drop. The Serbian economy has suffered greatly since the breakup of the old Yugoslavia.

Serbia's best farmland lies in Vojvodina and in Šumadija, an area south of Belgrade. Farmers grow corn, potatoes, sugar beets, and wheat. They also raise cattle, hogs, and sheep. Factories produce automobiles, cement, iron and steel, plastics, textiles, and trucks. Serbia has deposits of coal, copper, lead, and zinc.

A network of highways extends from Belgrade, but the rest of Serbia has fewer roads. Roads between some villages are unpaved. Railroads link Belgrade with major cities and towns in Serbia and nearby countries. Serbia has airports in Belgrade, Niš, and Priština. The Belgrade airport, which is the largest, handles international flights.

The leading daily newspapers in Serbia are *Večernje novosti, Politika ekspres, Politika,* and *Sport,* all published in Belgrade; and *Dnevnik,* published in Novi Sad.

History. In the A.D. 500's and 600's, various groups of Slavs, including the Serbs' ancestors, settled in the Balkan Peninsula in what is now Serbia. Each group had its own leader until the late 1100's, when Stefan Nemanja, a warrior and chief, formed the first united Serbian state. In the 1300's, Emperor Stefan Dušan led the country in successful wars against the Byzantine Empire. The Serbian empire began to break up after his death in 1355. The Ottoman Empire, based in what is now Turkey, defeated Serbia in the Battle of Kosovo Polje in 1389.

The Ottoman Empire conquered Serbia in the mid-1400's and ruled the region for over 400 years, but the Serbs never lost their national pride. Djordje Petrović, a Serbian peasant nicknamed Black George, led an uprising against the Ottomans in 1804. Another Serbian peasant leader, Miloš Obrenović, led a second revolt in 1815. The Serbs won some liberties in these struggles. Serbia regained independence only in 1878, following the Ottoman Empire's defeat by Russia in the Russo-Turkish War of 1877-1878. In the First Balkan Wars (1912-1913), Serbia and the other Balkan states gained control of most of the Ottoman Empire's territory in Europe.

In the early 1900's, various economic and political conflicts developed between Serbia and Austria-Hungary. In June 1914, the heir to the throne of Austria-Hungary, Archduke Franz Ferdinand, was assassinated by Gavrilo Princip, a Serb from the province of Bosnia-Herzegovina in Austria-Hungary. The assassination touched off World War I, which began a month later

© Linda Bartlett, Photo Researchers

Rich farmland covers much of Serbia. The republic's farmers grow a variety of crops. About half of the people of Serbia live in rural areas.

when Austria-Hungary declared war on Serbia. After the war ended in 1918, Serbia led the way in forming the Kingdom of the Serbs, Croats, and Slovenes. The kingdom was renamed the Kingdom of Yugoslavia in 1929.

During World War II (1939-1945), the Axis powers—led by Germany and Italy—occupied Yugoslavia and divided it among themselves. The Germans occupied most of Serbia. Communists led by Josip Broz Tito drove out the occupation forces. After the war, Tito and the Communists founded Yugoslavia with a federal government. Under this system, a central government and the republics shared power. Serbia became one of the country's six republics. Kosovo and Vojvodina became *autonomous* (self-governing) provinces of Serbia.

In 1989, Slobodan Milošević, a strong supporter of the expansion of Serbia's borders, became Serbia's president. Under him, Serbia stripped Kosovo and Vojvodina of autonomy and, in 1990, dissolved Kosovo's government. In 1991, Albanians in Kosovo voted in a referendum for independence. In 1992, they elected a new president and parliament. Serbia declared the referendum and the elections illegal. In 1990, Milošević was reelected in multiparty elections in Serbia. His party, the Socialist Party of Serbia, won control of the legislature.

Serbia always had more influence than any other republic in Yugoslavia's federal government. In June 1991, Croatia and Slovenia declared their independence, and Yugoslavia began to break apart. Serbs living in Croatia fought against the Croats. A cease-fire in January 1992 ended most of the fighting, but some continued.

In March 1992, the republic of Bosnia-Herzegovina declared its independence. Fighting then broke out in Bosnia-Herzegovina, pitting ethnic Serbs, who opposed independence, against Bosnian Muslims and Croats.

In April 1992, Serbia and Montenegro formed a new Yugoslavia. Milošević was reelected in December 1992.

In late 1995, the government of Croatia and Croatian Serb leaders agreed to end the war in Croatia. Also in late 1995, representatives of Bosnia, Croatia, and Serbia signed a peace plan for Bosnia-Herzegovina.

In 1997, Milošević's second term as president of Serbia ended. Yugoslavia's parliament elected Milošević president of Yugoslavia.

In early 1998, Serbian police attacked Kosovo in what Milošević said was a crackdown on the Kosovo Liberation Army, which demanded independence for Kosovo. Serbian forces destroyed villages in the province and drove many of Kosovo's Albanians from their homes.

The North Atlantic Treaty Organization (NATO) sponsored peace talks in early 1999, but Serbian delegates rejected the peace plan. In March, NATO began air strikes against military targets in Yugoslavia to force the government to accept the plan. But Serb attacks continued, and hundreds of thousands of people fled Kosovo. In June, Serbia agreed to a peace accord, and pulled its forces from Kosovo. NATO sent an international peacekeeping force to Kosovo. Many refugees returned, but tensions ran high between Serbs and Albanians in the province. Opposition to Milošević grew within Serbia.

In Yugoslavian presidential elections in 2000, opposition candidate Vojislav Kostunica won many more votes than Milošević. But Milošević and his allies claimed a runoff election was necessary. The opposition claimed victory, and protesters flooded the streets of Serbia's major cities to show their support for Kostunica. Police forces were overwhelmed by the size of the protests, and Milošević was ousted from power.

In 2002, the leaders of Serbia and Montenegro announced plans to create a new constitution for Yugoslavia and to rename the country Serbia and Montenegro. The plans sought to address the concerns of Montenegro's independence movement, which demanded more self-rule for the republic. Sabrina P. Ramet

Related articles in *World Book* include:

Austria-Hungary
Balkans
Belgrade
Bosnia-Herzegovina (History)
Croatia (History)
Kosovo
Milošević, Slobodan
World War I (Beginning of the war)
Yugoslavia (History)

Serbia and Montenegro is the proposed new name of the country of Yugoslavia. The country would consist of two republics, Serbia and Montenegro.

Serbia is much larger than Montenegro, and it has dominated national affairs. Many Montenegrins want their republic to become an independent country. In 2002, the leaders of Serbia, Montenegro, and Yugoslavia developed a plan to rename the country and to give Montenegro more political power. In exchange, Montenegro agreed to postpone seeking independence.

See also **Montenegro; Serbia; Yugoslavia.**

Serenade, *SAIR uh NAYD,* is a musical composition that has both instrumental and vocal forms. The instrumental form is more important in music history. This form consists of a collection of many short *movements*

(sections) written for a small group of stringed instruments, wind instruments, or both. The movements generally include such forms as marches and minuets.

Traditionally, a vocal serenade is the song a lover performs beneath his lady's window at night. The term comes from the Italian word *sera,* which means *evening.* While he sings, the lover usually accompanies himself with an instrument he can carry, such as a guitar. The Austrian composer Wolfgang Amadeus Mozart wrote a famous serenade, "Deh vieni alla finestra," in his opera *Don Giovanni* (1787). Thomas W. Tunks

Serf was a type of peasant who lived in Europe, mainly in the early Middle Ages. Serfdom developed in Western Europe in the 500's. At that time, the slave-based Roman agricultural system collapsed, and landowners began to grant their former slaves more freedoms.

Serfs were allowed to have their own houses and plots of land on large estates called *manors.* But serfs had to pay the owner of the manor, called a *lord,* heavy rents. These payments included money, farm products such as chickens or wheat, and a certain number of *work days.* On work days, serfs had to work in their lord's fields rather than their own. Serfs could not become priests or give testimony in court. They had to pay a fine if they wanted to marry serfs of a different lord. Unlike slaves, serfs themselves could not be bought and sold as property. But serfs were not free to leave the manor, either. When an estate was sold or given away, serfs were sold or given away as part of the property.

From about the 600's to the 1100's, most peasants in Western Europe were serfs, though there were some free peasants as well. As economic conditions improved in the 1100's and 1200's, many serfs in Western Europe sought their freedom. Some bought their way out of serfdom, and some ran away to the rapidly growing cities. Others moved to newly cleared lands where the landowners were looking for free, rent-paying tenants.

By the 1200's, few serfs were left in France and Italy. Most peasants there either owned land or rented it without losing their freedom. In England, several serfs' revolts took place before serfdom ended in the 1500's. Serfdom continued into the 1400's in western Germany. A few serfs there became wealthy and powerful, however. In eastern Germany and Russia, serfdom began in the 1300's and ended in the 1800's. Constance B. Bouchard

See also **Agriculture** (The Middle Ages); **Germany** (Serfdom in Germany); **Manorialism**; **Russia** (History).

Sergeant. See **Rank, Military.**

Sergeant at arms is an officer who keeps order during the meetings of clubs and deliberative bodies. The sergeant at arms also serves legal papers for the assembly. In addition, this officer has the power to compel members to attend sessions when their presence is necessary to make a quorum. Each branch of the United States Congress has an office for a sergeant at arms. When the sergeant at arms carries the *mace* (staff) down the aisle of the legislature, all disorder must cease (see **Mace**). Any disorderly member is guilty of contempt. Historians believe that the office of sergeant at arms was created by King Richard I of England. The king appointed a corps of 24 bodyguards to attend and guard him. Kenneth Janda

Series, in mathematics, is the sum of the terms of a sequence. For example, the set of numbers 2, 4, 6, 8, 10 form a *sequence.* If you add these numbers together, they form the *series* $2 + 4 + 6 + 8 + 10$. A sequence can be any set of *terms* (numbers or algebraic expressions) arranged in a specific order. A sequence with algebraic terms is a, ar, ar^2, ar^3, ar^4. The related series is $a + ar + ar^2 + ar^3 + ar^4$.

Mathematicians name series in a variety of ways to describe how the terms are formed. They call the series $2 + 4 + 6 + 8 + 10$ an *arithmetic series.* Each term of an arithmetic series is formed by adding a certain quantity to the preceding term. In this example, the quantity added is 2. (The sequence 2, 4, 6, 8, 10 is called an *arithmetic progression.*) The series $a + ar + ar^2 + ar^3 + ar^4$ is an example of a *geometric series.* Each term of such a series is formed by multiplying the proceeding term by a certain quantity called the *common ratio.* In this example, the common ratio is r. (The sequence a, ar, ar^2, ar^3, ar^4 is called a *geometric progression.*)

Other common types include power series, trigonometric series, and factorial series. The terms of a *power series* contain some quantity raised to successively higher powers. The simplest power series is $1 + x + x^2 + x^3 + x^4 + x^5$ and so on. The terms of a *trigonometric series* contain such expressions as sines and cosines of angles. A simple *factorial series* has the form $1 + (1 \times 2) + (1 \times 2 \times 3)$ and so on. When written in *factorial notation,* this series appears as follows: $1! + 2! + 3!$.

Series that become important mathematical tools are often named for the individuals who develop them. Fourier series are used in physics in the study of waves. Taylor series contributed to the growth of calculus.

All series are either *finite* or *infinite,* depending on the number of terms they have. A finite series has a definite number of terms that you can count. For example, the series $2 + 4 + 6 + 8 + 10$ is a finite series because it has only 5 terms. An infinite series goes on indefinitely so that you cannot count the number of terms. For example, the sum of all the numbers used in counting by 2's is an infinite series. It is written:

$$2 + 4 + 6 + 8 + 10 + \ldots$$

The dots at the end of the series indicate that there is no "last" term. Instead, an infinite number of terms follow the ones that are written.

Working with finite series

The most common questions asked about a finite series are: (1) What is the value of a certain term? (2) What is the sum of a certain number of terms? For example, suppose you want to find the 7th term in the sequence of odd numbers (1, 3, 5, 7, 9, and so on). You can find the answer by writing the following sequence of numbers:

$$1, 3, 5, 7, 9, 11, 13$$

The example shows that the 7th term is 13. In a similar way, you can find the sum of the first 7 terms in the related series:

$$1 + 3 + 5 + 7 + 9 + 11 + 13$$

Adding the terms shows that the sum is 49.

You can also use mathematical formulas to find terms and sums of many series. The formulas are especially helpful when you must work with a large number of terms. In the formulas, the letter n usually represents the

number of a term. For example, the formula for the nth term (U_n) in the sequence of odd numbers is

$$U_n = 2n - 1$$

Using this formula, you can calculate the 7th term in the sequence as follows:

$$U_7 = (2 \times 7) - 1 = 14 - 1 = 13$$

This is the same answer that you obtain when you write out the sequence of numbers. The mathematical formula for the sum of the first n terms (S_n) of the odd-numbered series is

$$S_n = n^2$$

The sum of the first 7 terms is therefore

$$S_7 = 7^2 = 49$$

Again, your answer agrees with the sum you obtain by adding the terms.

Mathematicians have developed similar formulas for finding terms and sums of many kinds of series. For more information about finding terms and sums of progressions, see the article on **Progression.**

Working with infinite series

Probably the simplest infinite series is a geometric series whose common ratio is less than 1. For example, the following geometric series has a common ratio of $\frac{1}{2}$:

$$1 + \tfrac{1}{2} + \tfrac{1}{4} + \tfrac{1}{8} + \tfrac{1}{16} + \ldots$$

How do you find the sum of this series if it has an infinite number of terms? You can start by making a table showing the sum of the first two terms, the first three, the first four, and so on.

Number of terms (n)	Last term	Sum of n terms
1	1	1
2	$\frac{1}{2}$	$1\frac{1}{2}$
3	$\frac{1}{4}$	$1\frac{3}{4}$
4	$\frac{1}{8}$	$1\frac{7}{8}$
10	$\frac{1}{512}$	$1\frac{511}{512}$

The table shows that the sum gets closer to 2 as you add more terms. If you add enough terms, you can make the sum come as close to 2 as you wish. But the sum never reaches 2. The number 2, then, is called the *limit of the sum of n terms as n increases without bound.* You can express this statement with mathematical symbols as follows:

$$\lim_{n \to \infty} S_n = 2$$

The symbols $n \to \infty$ signify that the number of terms increases without bound. Such a limit may also be called merely the "sum" of the series.

You can use mathematical formulas to prove that the sum of this series is 2. The formula for the sum of n terms (S_n) of any geometric progression is:

$$S_n = \frac{a - ar^n}{1 - r}$$

In this formula, a represents the first term of the series, r the common ratio, and n the number of terms. The expression in the preceding column can also be written as two terms:

$$S_n = \frac{a}{1 - r} - \frac{ar^n}{1 - r}$$

Consider the second term in the above formula. Let the common ratio, r, be any number less than 1. Then, as the number of terms, n, increases without bound, the factor r^n approaches zero. The limit of the second term is therefore zero. (You may want to tabulate some values for the second term to see why this is so. Make r any value less than 1. Then calculate the value of the second term for several increasing values of n.)

The second term of the formula is zero only when n increases without bound. Therefore, we must write:

$$\lim_{n \to \infty} S_n = \frac{a}{1 - r}$$

To put this formula to work, we merely insert the proper values. In our example, $a = 1$, and $r = \frac{1}{2}$:

$$\lim_{n \to \infty} S_n = \frac{1}{1 - \frac{1}{2}} = \frac{1}{\frac{1}{2}} = 2$$

The formula shows that the limit of the sum is 2, the same number arrived at when the series of terms was tabulated.

When the sum of a series approaches a limit as the number of terms increases without bound, the series is said to *converge.* Otherwise, the series is said to *diverge.* Mathematicians can prove that many series converge. However, even though convergence can be proved, it is often difficult or impossible for mathematicians to develop a formula for the sum. In such cases, the sum must be obtained approximately by adding terms in the series. In this way, mathematicians calculate many important quantities. These quantities include the trigonometric functions; logarithms; and mathematical constants such as π and e (the base of the natural logarithms).

One of the early expressions for π was developed by the Scotch mathematician James Gregory (1638-1675):

$$\pi = 4(1 - \tfrac{1}{3} + \tfrac{1}{5} - \tfrac{1}{7} + \tfrac{1}{9} - \tfrac{1}{11} + \ldots)$$

The terms of this series form a *harmonic progression.* Gregory's series converges slowly. This means you have to add a large number of terms to extend the accuracy only slightly. Today, mathematicians use other series that converge more rapidly to the value of π. The expression below shows π carried out to 20 decimal places:

$$\pi = 3.14159265358979323846$$

With rapidly converging series and the aid of high speed computers, mathematicians can obtain a value of π correct to more than 100,000 decimal places.

For the series used to calculate e, see **Logarithms** (Natural logarithms).

Working with odd numbers

Consider the formula for the sum of the series of odd numbers ($1 + 3 + 5 + 7 + \ldots$):

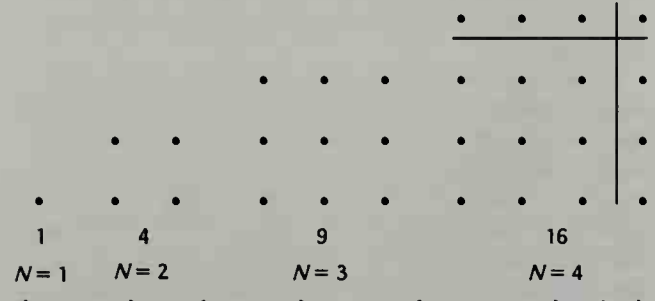
$$S_n = n^2$$

This formula points out a remarkable fact: *the sum of n*

successive odd numbers is always a perfect square. The table below illustrates this fact.

Number of terms	Last term of series	Sum of *n* terms
n	$2n-1$	n^2
1	1	1
2	3	4
3	5	9
4	7	16
5	9	25
6	11	36
7	13	49
8	15	64
9	17	81
10	19	100

The arrows in the table show the relation between the perfect squares and the successive odd numbers. Followers of the Greek mathematician Pythagoras knew this relationship as early as 540 B.C. They discovered it while studying figurate numbers. *Figurate numbers* are dots arranged in the form of squares, triangles, and other geometrical figures. For example, the Pythagoreans represented the first 4 perfect squares as follows:



They saw that to form each new perfect square they had to add an odd number of dots to the preceding square. The number of added dots increased by 2 each time. Thus, the dots formed a sequence of odd numbers. To the number 1, the Pythagoreans added 3 dots to make 4, then added 5 more dots to make 9, and so on. The last diagram shows how the Pythagoreans formed 16 by adding dots to 9. They added (1) 3 dots in a row along the top; (2) 3 more in a column on the right side; and (3) a single dot in the upper right corner. The total number of dots added was $(2 \times 3) + 1 = 7$, an odd number.

In general, N can be used to represent the number of dots in a row or column of any square number. Then, to form the next square, one has to add (1) N dots in a row along the top; (2) N more in a column on the right side; and (3) a single dot in the upper right corner. The total number of dots added would be $(2N + 1)$, which is always an odd number. With each new square, N increases by 1. As a result, the number of added dots $(2N + 1)$ increases by 2. Thus the number of added dots forms a sequence of odd numbers. Also, each perfect square is the sum of a certain number of terms in the odd-number series. Jeffrey C. Barnett

Serling, Rod (1924-1975), an American dramatist, was one of the first writers to reach playwright status solely through performances of his works on radio and television. He began his career writing radio scripts in 1948, and turned to television in 1950. His major TV dramas include *Patterns* (1955) and *Requiem for a Heavyweight* (1956). Serling probably became best known as the creator and host of the science-fiction TV series *The Twilight Zone* (1959-1965). He also co-wrote the script for the science-fiction film *Planet of the Apes* (1968). Serling was born in Syracuse, New York. Mardi Valgemae

Serotonin, *SIHR aw TOH nuhn,* is a chemical that acts in the brain and other parts of the body to influence many feelings, behaviors, and processes. Some of the important functions regulated by serotonin include appetite, sleep, aggression, mood, and sex. In the brain and the rest of the nervous system, serotonin acts as a *neurotransmitter,* a chemical that carries signals from one *neuron* (nerve cell) to another. In many cases, serotonin acts by modifying the effects of other neurotransmitters. Serotonin also helps shape early brain development. Serotonin occurs widely in plants and in other animals as well as in people.

A group of cells in the *brain stem* (base of the brain) produce serotonin from an amino acid called *L-tryptophan.* Serotonin is also made in the digestive system and by certain skin and blood cells. Cells that respond to serotonin have structures called *serotonin receptors* on their surfaces. Scientists have identified more than a dozen kinds of serotonin receptors in different areas of the body. Serotonin's effects depend, in part, on which types of receptors are activated. Because of hereditary differences, people vary in how their nerve cells respond to serotonin.

Serotonin's many effects on the body make it a promising target for drugs. For example, drugs that raise serotonin levels in the nervous system are prescribed for treatment of depression. Other drugs that target serotonin treat such conditions as autism, migraine headaches, and schizophrenia.

F. Xavier Castellanos

See also **Antidepressant; Brain** (The brain's chemical messengers; picture: Networks of neurons); **Depression; Migraine; Schizophrenia.**

Serpent. See **Sea serpent; Snake.**

Serpentine, *SUR puhn teen,* is a mineral which occurs in *metamorphic rock*—that is, rock that has changed its appearance due to heat and, in some cases, pressure. Its chemical composition is $Mg_3Si_2O_5(OH)_4$.

Serpentine is found in three forms—*chrysotile, antigorite,* and *lizardite.* Chrysotile, a fiberlike variety, is the most important type of asbestos. However, its use is now limited due to health problems associated with asbestos. Chrysotile has been mined in Canada, Kazakhstan, Russia, and South Africa. Antigorite, a flaky variety, occurs as massive rocks that often have green spots. Antigorite is used as a polished ornamental stone called *verd antique* or *serpentine marble.* Lizardite is difficult to tell apart from antigorite, except by analysis with X rays.

David F. Hess

See also **Asbestos; Metamorphic rock.**

Serra, *SEHR rah,* Junípero, *hoo NEE peh ROH* (1713-1784), was a Franciscan missionary who in 1769 founded the first mission in present-day California. This mission, San Diego de Alcalá, was built near San Diego Bay.

Serra was born and educated in Majorca, a Spanish island. He entered the Franciscan religious order in 1730 and was ordained a priest in 1738. He taught philosophy in Majorca and, in 1749, sailed to Mexico to join the San Fernando College in Mexico City. Serra was named superior of the Franciscan missions in Lower California (a

part of Mexico) in 1767. In 1988, Serra was *beatified* by the Roman Catholic Church. Beatification is the last step before sainthood is conferred. A statue of Serra represents California in Statuary Hall in the United States Capitol. James A. De Jong

See also Mission life in America (Western missions); California (History [The California Missions]).

Sertoma International, *SUR TOH muh,* is a civic service organization of clubs in Canada, Mexico, Puerto Rico, and the United States. Its name comes from the *Ser, to,* and *Ma* in the slogan "Service to Mankind." Membership is made up of professional people. The clubs raise money for scholarships, community service, and the sponsorship of speech and hearing clinics and other projects. They also promote appreciation of national heritage in an annual Freedom Week by sponsoring essay contests and distributing copies of historic documents to schoolchildren. The organization has more than 30,000 active members in about 1,000 clubs. The organization was founded in 1912. It has headquarters in Kansas City, Missouri.

Critically reviewed by Sertoma International

Serum, *SIHR uhm,* is the clear, fluid part of the blood that is left after a clot forms. Serum is like *plasma* (the total liquid part of the blood) except that serum does not contain *fibrinogen,* a substance that causes clotting.

Serum contains such substances as salt, proteins, glucose, and fats. Samples of serum are used to help *diagnose* (determine) the medical problems of patients. Tests on blood serum are called *serologic tests.*

Serum proteins contain *antibodies* produced by the body to fight diseases and *toxins* (poisons). A serum containing antibodies that is taken from a person or animal and injected into a patient is called an *antiserum.* Antiserums work against diseases like diphtheria and *tetanus* (lockjaw). *Antitoxins* are types of antiserums.

Serum taken from a person who has recently recovered from a disease usually contains more than the normal amount of antibodies. This serum may help cure or prevent the disease. However, doctors have found a more efficient way of providing disease-fighting antibodies. Instead of using the entire serum, they inject only a part of the serum called *gamma globulin.* Gamma globulin is a class of proteins that contains most of the blood's antibodies. Gamma globulin preparations are used to fight and prevent hepatitis, measles, mumps, and whooping cough.

Serum obtained from animals is easier to obtain and costs less than serum from human beings. But it is often less effective and more dangerous than human serum. A horse is usually used because it has a large amount of blood and produces many antibodies. Horse antiserums are used to prevent rabies and to treat persons bitten by poisonous snakes and black widow spiders. They are also used to treat *botulism* (food poisoning), gas gangrene, and rabies. However, some patients are *allergic* (extremely sensitive) to animal proteins and may have serious reactions. Joseph V. Simone

See also Antitoxin; Blood transfusion; Gamma globulin; Plasma.

Serval, *SUR vuhl,* is a large wildcat that lives in Africa, from the Cape of Good Hope north to Senegal and the Sudan. The male serval is from 3 to 4 feet (91 to 120 centimeters) long and stands 18 to 23 inches (46 to 58 centimeters) tall at the shoulder. The male has a 12-inch (30-centimeter) tail and large ears. Servals are easy to tame if they are captured when young. However, they are difficult to raise. They are usually taken in snares or are treed by dogs. Servals hide in bushes along riverbanks, waiting for their prey. They eat small fowl and other creatures up to the size of small antelope. Servals generally hunt on the ground. However, these animals are expert climbers, and they often go into the trees after birds. Elizabeth S. Frank

Mark N. Boulton, Bruce Coleman Ltd.

A serval is a large wildcat with a head much like that of a domestic cat. A serval has a black-spotted, tawny coat.

Scientific classification. The serval is a member of the cat family, Felidae. its scientific name is *Felis serval.*

Service, Robert William (1874-1958), was a Canadian poet known for his lively ballads about frontier life in the Yukon Territory. Many of his ballads also describe the beauty of the Yukon.

Service was born in Preston, England, and grew up in Glasgow, Scotland. He moved to Canada in 1894 and held various jobs in the Canadian and American West. In 1902, he moved to the Yukon and worked as a bank clerk in Dawson and Whitehorse.

Service's first book of verse, *Songs of a Sourdough* (1907), also published as *The Spell of the Yukon,* was an immediate success. This book included his best-known ballads, "The Shooting of Dan McGrew" and "The Cremation of Sam McGee." They portray the hardship and violence of life in the Yukon during the gold rush of the late 1890's. Service wrote several other books of verse. He also wrote six novels, which were not as successful as his ballads.

Service left the Yukon in 1912 and traveled extensively. In *Rhymes of a Red Cross Man* (1916), he described his experiences as an ambulance driver during World War I. He spent most of his later life in France. Service wrote a two-volume autobiography, *Ploughman of the Moon: An Adventure into Memory* (1945) and *Harper of Heaven: A Record of Radiant Living* (1948). Rosemary Sullivan

Service Employees International Union is one of the largest labor unions in the United States and Canada. The union, often called SEIU, consists of more than 300 local unions in the two countries. It represents service workers in over 100 occupations. These occupations are organized into five main divisions: health care, public employment, office and clerical, building service, and

light industrial. Women make up half the membership. SEIU is affiliated with the American Federation of Labor and Congress of Industrial Organizations (AFL-CIO).

SEIU was founded in Chicago in 1921. In 1934, the union gained thousands of new members when it called a strike in the New York City garment district. In the late 1900's, its membership continued to grow with the development of many new service jobs in the United States and Canada. National headquarters are in Washington, D.C. For membership, see **Labor movement** (table).

Critically reviewed by the Service Employees International Union

Service industries are the business firms and government and nonprofit organizations that produce services rather than manufactured goods or agricultural products. Services consist mainly of such activities as selling goods in a store and providing financial advice. Service industries may be grouped into such broad categories as amusement and recreation, automobile services, education, health care, and household services.

Since the mid-1900's, service industries have played an increasingly large role in the economy of many industrial nations. The United States has many more service companies than manufacturing companies. Service industries account for about three-fourths of the U.S. *gross domestic product*—the value of all goods and services produced in a year. They also employ about three-fourths of the country's workers.

Today, the fastest-growing service industries include fast-food restaurants, government, health care, and amusement and recreation. Computer, legal, and other business services also are expanding rapidly. Production and employment have decreased in gasoline stations, housecleaning businesses, and laundries.

Most economists believe that the growth of service industries represents an advanced stage of national economic development. They say that a nation develops service industries on a large scale only after its agricultural and manufacturing industries have reached high levels of production and can maintain those levels with fewer and fewer workers. Agricultural and manufacturing industries can reduce their payrolls by substituting machines for workers. This is more difficult to do in service industries. Edwin J. Perkins

See also the *Economy* section of the state, province, and country articles; the *Related articles* listed under *Service industries* in the **Industry** article; **Careers**.

Servomechanism, *sur voh MEHK uh nihz uhm,* is a type of control system that automatically corrects errors in the position, velocity, or acceleration of an object. Industry uses servomechanisms to control automatic machines such as robots.

In a servomechanism, a *sensing device* measures the characteristic to be controlled—the position, velocity, or acceleration of an object. This device then sends a signal representing this characteristic to another device, called a *controller.* The controller produces a signal that represents the desired position, velocity, or acceleration and compares this signal with the signal from the sensing device. The difference between the signals, known as the *error signal,* is used to control the object until the error signal approaches zero. For example, the automatic flight control system used in airplanes has a servomechanism that compares the desired course of the airplane with the actual course. The error signal represents any difference between the two, and is used to operate the controls of the airplane until it is back on course. When the airplane is on course, the error signal is zero. See **Automatic flight control system.**

Much early development of servomechanisms occurred during World War II (1939-1945). Servomechanisms on warships, for example, used signals from radar antennas to aim antiaircraft guns. Ralph V. Calhoun

See also **Automation.**

Sesame, *SEHS uh mee,* is an herb grown in tropical countries. It is grown mainly for the oil obtained from its seeds. It originally grew in Africa or India and is now widely cultivated in China, India, Japan, Mexico, and the Southwestern United States. An annual, it grows about 2 feet (61 centimeters) high. Its leaves are oblong, and its small flowers are pink or white, depending on the variety. Small capsules contain flat seeds from white to brown in color. The oil obtained from sesame seeds is straw-colored and is similar to olive oil. It is used in salad dressings and in cooking. The seeds have a delicious taste and are used to flavor bread, biscuits, candy, and other delicacies.

WORLD BOOK illustration by John D. Dawson

The sesame plant bears capsules that contain seeds.

David S. Seigler

Scientific classification. The sesame plant is in the pedalium family, Pedaliaceae. Its scientific name is *Sesamum indicum.*

Sesshu, *sehs shoo* (1419-1506), a Buddhist monk, was the greatest Japanese landscape painter in the tradition of Chinese ink drawing. His style is easy to recognize by its bold compositions, forceful drawing, and disregard of subtle modeling. His masterpiece is a long scroll showing Chinese river scenery. Sesshu learned his art by studying the works of Chinese ink masters of the 1200's. Robert A. Rorex

Sessions, Roger (1896-1985), was an American composer and teacher. His compositions are intense, serious, and intellectual. Sessions wrote in the modern 12-tone technique, but he believed a composer should not be limited to one particular musical system. Sessions wrote for orchestra, chamber groups, chorus, solo voice, organ, and piano. He also composed two operas. His most popular work is the orchestral suite *The Black Maskers* (1923). Sessions won the 1982 Pulitzer Prize for music for *Concerto for Orchestra* (1981).

Roger Huntington Sessions was born Dec. 28, 1896, in New York City. He studied with the Swiss-born composer Ernest Bloch, who became the major influence on his style. Sessions taught at Princeton University from 1935 to 1945 and from 1953 to 1965, and also taught at other universities. Sessions wrote *The Musical Experience of Composer, Performer and Listener* (1950) and *Harmonic Practice* (1951). Many of his essays were collected in *Roger Sessions on Music* (1979). Leonard W. Van Camp

Set. See **Seth.**

Set theory is a way of solving problems in mathematics and *logic* (reasoning). By studying set theory, you can get a better understanding of arithmetic and of mathematics as a whole.

A *set* is a collection of objects or ideas. For example, a family, a box of crayons, a flock of sheep, the rules of a game, and the even numbers from 10 to 20 are all sets. The items that make up a set are the *members* or *elements* of the set. A red crayon is a member of a set of crayons. The number 16 is a member of the set of even numbers from 10 to 20.

Mathematicians use letters to name sets and the members of sets. Capital letters commonly represent sets, and lower-case letters refer to the members of sets. For example, the letter C might stand for the set of fifth-grade girls with curly hair. The letters m, s, and r might represent the members of this set—Martha, Sara, and Ruth.

A common way to define a set is to enclose the symbols that represent its members in *braces* { }. Thus, you would write: $C = \{\text{Martha, Sara, Ruth}\}$ or simply $C = \{m,s,r\}$.

The symbol $\in$ indicates that a member belongs to a certain set. For example, $s \in C$ is read: "s is a member of C." To show that j does not belong to C, write $j \notin C$, which is read: "j is not a member of C."

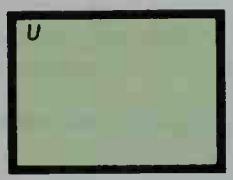
In addition to defining a set by its members, mathematicians may also define it in terms of its properties. A *property* is a characteristic that relates the members of a set to one another. In the example above, C has three properties: (1) its members are girls, (2) its members are in the fifth grade, and (3) its members have curly hair. To define the set by these properties, you would write: $C = \{x | x \text{ is a fifth-grade girl with curly hair}\}$. This statement is read: "C is the set of all members, x, such that x is a fifth-grade girl with curly hair." The vertical line between the two x's means "such that."

Mathematicians also use various combinations of circles and rectangles to define sets, show relationships, and solve problems. Such drawings are called *Venn diagrams* or *Euler's circles*.

Kinds of sets

In working with set theory, mathematicians compare one set with another. Mathematicians have given names to various kinds of sets to aid in the comparisons. Ten major kinds of sets are (1) universal, (2) finite, (3) infinite, (4) empty, (5) single element, (6) equivalent, (7) equal, (8) overlapping, (9) disjoint, and (10) subsets. Every set can be called by more than one of these names.

Universal sets consist of all members being considered at any one time. Mathematicians call such a set a *universe* and usually represent it by the letter U. For example, if a certain problem deals with only the whole numbers from 1 to 10, then $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. In another problem, the universe might be all girls in the fifth grade or all even numbers. The Venn diagram of the universal set is shown below.



Finite sets and infinite sets. A *finite set* has a definite number of members. "Three cats" and "three thousand head of cattle" are finite sets. An *infinite set* has an endless number of members. For example, the numerals you use in counting form an infinite set. They include 1, 2, 3, 4, 5, and so on without end. It is impossible to list all the members of an infinite set. One way to represent such a set is to list the first few members and then write three dots: $\{1, 2, 3, \ldots\}$.

Empty sets, also called *null sets,* have no members. The following sets show which students were absent from school on three days. Monday: Paul, Frances. Tuesday: Joe. Wednesday: No one absent. The Monday set of absentees has two members and the Tuesday set has one member. The Wednesday set has no members; it is an empty set. To show an empty set, leave a blank space between a pair of braces, or write the symbol $\emptyset$. Thus, students absent on Wednesday $= \{\ \} = \emptyset$.

Single element sets contain only one member. In the example above, the set of students absent on Tuesday, {Joe}, is a single element set.

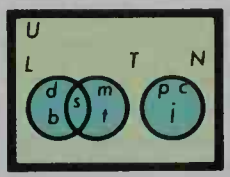
Equivalent sets have the same number of members. For example, if there are four desks and four students in a classroom, the set of desks is equivalent to the set of students. To show that A and B are equivalent, write: $A \leftrightarrow B$. The symbol $\leftrightarrow$ is read: "is equivalent to." If the classroom has five desks and four students, then the sets are not equivalent. To show this, write $A \nleftrightarrow B$, which is read: "A is not equivalent to B."

Equal sets have the same members. Suppose that the set of students who received 100 per cent on a spelling test is $S = \{\text{Pete, Mark, Joan, Tom}\}$. Suppose further that the set of students who received 100 per cent on an arithmetic test is $A = \{\text{Tom, Joan, Pete, Mark}\}$. S is equal to A because the sets have the same members. To indicate that the sets are equal, you would write: $S = A$.

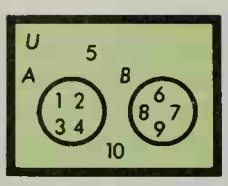
Overlapping sets and disjoint sets. *Overlapping sets* have some members in common. If the set of last year's class officers is $L = \{\text{Dick, Susan, Betty}\}$ and the set of this year's officers is $T = \{\text{Mark, Susan, Tom}\}$, sets L and T overlap because Susan belongs to both sets.

Disjoint sets have no members in common. Suppose the set of students running for office next year is $N = \{\text{Patty, Carmen, Jim}\}$. Set N is disjoint from L and T because it does not have any elements in common.

The Venn diagram below shows the relationships between sets L, T, and N.



Subsets are contained within other sets. For example, the set of fifth-grade girls with curly hair is a subset of the set of all fifth-graders. In another example, consider the universe of $\{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. If set $A = \{1, 2, 3, 4\}$ and set $B = \{6, 7, 8, 9\}$, then A and B are subsets of the set U. To show this, you write $A \subset U$ and $B \subset U$. The symbol $\subset$ is read: "is included in." Subsets A and B are finite sets because they have a definite number of members. Subsets A and B are also equivalent sets because they have the same number of members, and



$A \subset U$
$B \subset U$

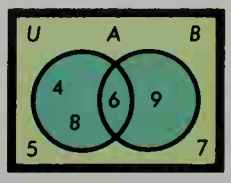
they are disjoint sets because no members belong to both *A* and *B*.

Using set theory

In algebra, sets are helpful in understanding and solving problems. Suppose that in a certain problem the letter *x* stands for any number from 1 to 10 and you are to find what the value or values of *x* are under certain conditions. In this problem, *x* is a *variable* and the set of numbers from 1 to 10 is the *domain of the variable*. The solution is the set of all numbers in the domain that make a true statement when substituted for *x* under the conditions given. Such a set is called a *solution set*.

Suppose, for example, that the domain of *x* is $U = \{4, 5, 6, 7, 8, 9\}$ and you are to find the values of *x*, such that (1) *x* can be divided evenly by 2, or (2) *x* can be divided evenly by 3. The word *or* connecting the two conditions means you need the *union* (combination) of the solutions for the two conditions. This combination is written $A \cup B$, which is read: "*A* union *B*."

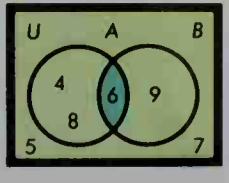
To solve this problem, divide each member of the domain by 2. Then use your results to define the solution set for the first condition thus: $A = \{4, 6, 8\}$. Next, divide each member of the domain by 3 and define the solution set for the second condition as $B = \{6, 9\}$. The solution set for the whole problem is $A \cup B$, which equals {4, 6, 8, 9}, as shown by the shaded area in the Venn diagram below.



$A \cup B$

Depending on the problem, a solution set may be an empty set, or it may have any number of members. See **Algebra** (Learning algebra).

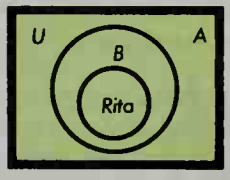
When the conditions of a problem are connected by the word *and*, the solution set is the *intersection* (overlap) of the solutions for the conditions. This set is written $A \cap B$, which is read "*A* intersect *B*." Suppose, as in the previous problem, the domain of *x* is $U = \{4, 5, 6, 7, 8, 9\}$, but this time you are to find the values of *x*, such that (1) *x* can be divided evenly by two, and (2) *x* can be divided evenly by three. In solving the solution sets for the conditions, you again find $A = \{4, 6, 8\}$ and $B = \{6, 9\}$. However, this time the solution set for the whole problem is $A \cap B$, which equals {6}, as shown by the shaded area in the diagram below.



$A \cap B$

In logic, set theory can help you form conclusions based on statements called *premises*. Suppose, for example, a logic problem has two premises: (1) All sixth-grade girls are members of the school glee club, and (2) Rita is a sixth-grade girl. Suppose you are to determine whether Rita is a member of the club.

To solve this problem using set theory, let *A* be the set of members of the school glee club, and let *B* be the set of girls in the sixth grade. According to the first premise, *B* is a subset of *A*. That is, every member of *B* is a member of *A*. According to the second premise, Rita belongs to set *B*. Therefore, Rita must also belong to set *A*. Thus, you conclude that she is a member of the school glee club. The Venn diagram for this problem is shown below.



History

The set theory studied in elementary and high schools developed from two mathematical discoveries of the 1800's. These discoveries were called *symbolic logic* and *the theory of sets*.

Symbolic logic is a way of using mathematical symbols and operations to solve problems in logic. George Boole (1815-1864), an English mathematician, established the basis of this technique in the 1840's.

In the 1870's, the German mathematician Georg Cantor (1845-1918) applied some of the ideas of symbolic logic to sets of numbers. He formed a theory that he called "the theory of sets." Cantor developed this theory because of his interest in infinite quantities. For example, he showed how the members of certain infinite sets could be matched one for one against each other. The set of counting numbers can be matched against the set of even numbers as follows:

1, 2, 3, 4, 5, and so on;

2, 4, 6, 8, 10, and so on.

Both sets are infinite and equivalent, even though the second is a part of the first.

In the 1950's and 1960's, mathematicians and educators recognized that the ideas of set theory could help students understand the principles of arithmetic and mathematics. The study of sets became a part of what was called the "new mathematics." By studying sets, students learned the meaning of such basic ideas as *number* and *numeral*. They also learned to apply mathematics to the field of logic.

After the 1960's, however, mathematicians and educators decided to return their attention to the development of basic computational skills. By the late 1980's, they were emphasizing the solving of problems.

Jeffrey C. Barnett

Related articles in *World Book* include:

Algebra
Arithmetic
Boolean algebra
Geometry
Logic
Mathematics

New mathematics
Numeration systems

Seth, also called Set, was an ancient Egyptian god of storms, violence, darkness, and desert land. He was also a god of desert animals, serpents, pigs, hippopotamuses, and crocodiles.

Seth was identified with an animal that had the body of an elongated jackal or greyhound; a long neck; a thin, curved snout; rectangular, upraised ears; and a stiff, forked tail. Seth was often portrayed with a human body and the head of this beast.

The Egyptians saw Seth's violent characteristics as potentially beneficial. They believed that Seth defended the sun god, Re, during his daily journey across the sky when he was threatened by the dangerous Apophis serpent.

Egyptian kings attributed their ferocious warlike power to Seth. His cult flourished in the Egyptian delta where the Hyksos invaders settled during the 1700's B.C. (see **Hyksos**). Seth was also popular among the pharaohs of Dynasty XIX (about 1291-1183 B.C.).

In the myth of Osiris, Seth is the villain. Seth is jealous of his brother Osiris, Egypt's reigning king. He tricks and kills Osiris, and cuts him into pieces. Orval Wintermute

See also **Mythology** (Egyptian mythology; picture); **Osiris.**

Seti I, *SEH tee* (reigned about 1303-1290 B.C.), was a king of ancient Egypt. Early in his reign he conducted at least two campaigns in Syria in an effort to check the advance of the Hittites and to reestablish the empire of Thutmose III in Palestine and Syria.

Seti built the temple of Abydos. He also decorated the walls of the Great Hypostyle Hall (hall of columns) at Karnak, which his son Ramses II completed. Seti's tomb was discovered in the Valley of the Kings in 1817. His mummy, along with that of Ramses II, was found in 1881, in another tomb located near Dayr al Bahri.

Leonard H. Lesko

See also **Ramses II.**

SETI Institute is a research organization that is trying to determine whether life has developed anywhere other than Earth. The term *SETI* stands for the *s*earch for *e*xtra*t*errestrial *i*ntelligence. But researchers at the institute are interested in finding any form of life beyond Earth, however intelligent that life may be. The institute was founded in 1984, and it is located in Mountain View, California.

About 40 different research projects are being conducted at the SETI Institute. The organization's largest undertaking is Project Phoenix. In this project, researchers try to detect radio signals from intelligent beings that might live on planets orbiting nearby stars. Project Phoenix is the successor to a search that had been conducted by the National Aeronautics and Space Administration (NASA). In 1993, Congress ended the funding for this search. The SETI Institute then began Project Phoenix with private support.

In partnership with the University of California at Berkeley, the institute plans to build a huge *array* (group) of radio telescopes. The small dish antennas of the array would have a combined area of 10,000 square meters.

Jill C. Tarter

See also **Extraterrestrial intelligence; Telescope** (Radio telescopes).

Seton, *SEET uhn,* **Ernest Thompson** (1860-1946), was the pen name of a popular Canadian writer and illustrator of animal and woodcraft books for young people. He helped found the Boy Scouts of America, wrote the first Scout manual, and was Chief Scout for five years. He also founded the Woodcraft Indians, an organization of boys and girls.

Seton was born Ernest Seton Thompson on Aug. 14, 1860, in South Shields, England, and moved to Canada with his family in 1866. He won fame with such books as *Wild Animals I Have Known* (1898), *Lives of the Hunted* (1901), and *Two Little Savages* (1903). Jill P. May

Seton, *SEET uhn,* **Saint Elizabeth Ann** (1774-1821), was the first person born in the United States to be recognized as a saint by the Roman Catholic Church. She was *canonized* (declared a saint) in 1975. Saint Elizabeth Ann Seton, who is also called Mother Seton, founded the Daughters of Charity of St. Vincent de Paul (now often called Sisters of Charity), the first Catholic religious community that originated in the United States. She also pioneered in Catholic education in the United States.

St. Joseph Provincial House, Emmitsburg, Maryland

Elizabeth Ann Seton

Mother Seton was born Elizabeth Ann Bayley on Aug. 28, 1774, in New York City. In 1794, she married William M. Seton, a wealthy New York City shipping merchant. The couple had five children. William Seton died in 1803, and Elizabeth became a member of the Catholic Church two years later.

In 1808, Elizabeth Seton settled in Baltimore and established the Paca Street School, the first Catholic elementary school in the United States. She took religious vows in 1809 and founded the Daughters of Charity in Emmitsburg, Maryland, that same year. In 1814, she established the Orphan Asylum of Philadelphia, the nation's first Catholic child-care institution. Her feast day is January 4. Anne E. Carr

Setter is a type of long-haired hunting dog. It is used to search for such birds as quail and partridge. There are three breeds of setters: *English, Gordon,* and *Irish.* All have silky coats, expressive eyes, and heavy muzzles. They are intelligent and gentle. Breeders in the United States classify setters as sporting dogs. The setter was developed from the old "setting spaniel." Setters are about the same size and shape as pointers, but have the spaniel's long hair.

A setter hunts game in the same way that pointers do (see **Pointer**). It ranges the field until it smells game. Then it comes to a *point,* with its nose pointing at the game, its body stiff, and its tail out straight or raised a little. Sometimes it lifts one front paw while pointing. The dog holds its point until the hunter *flushes* the game (makes it move from its hiding place). After the shot, the setter brings back the game.

Critically reviewed by the American Kennel Club

See also **Dog** (pictures: Sporting dogs); **English setter; Gordon setter; Irish setter.**

Settlement house is an institution that tries to improve living conditions in city neighborhoods. A settlement house, also known as a *neighborhood center* or a *social settlement,* offers various services, depending on its sponsorship and the changing needs of the community. Typical services include clubs for people of all ages; health, social, recreational, and educational activities; and cultural events.

In addition to providing numerous direct services, settlement houses contribute to reform efforts in housing, immigration, civil rights, and child and family welfare. Activities at a settlement house are led by professionals and volunteers.

The first settlement house, Toynbee Hall, was founded in London in 1884 by a group of Oxford University students. In 1886, Stanton Coit, an American social reformer, established the first settlement house in the United States—University Settlement in New York City. Three years later, Jane Addams and Ellen Gates Starr opened Hull House in Chicago.

The United Neighborhood Centers of America provides information and coordination for centers in the United States. The International Federation of Settlement Houses and Neighborhood Centers has its headquarters in London. Emma Giordano Quartaro

See also Addams, Jane; Hull House; Social work; Toynbee, Arnold; Wald, Lillian D.

Seurat, *suh RAH,* **Georges,** *zhawrzh* (1859-1891), a French artist, was one of the inventors and chief painters of a painting style called Pointillism (also called Divisionism or Neoimpressionism). In Pointillism, the painter tries to represent the activity of light and to unify the picture by the interplay of colors. Instead of using brushstrokes, the painter places dots of pure color side by side. Seen from a distance, the colors are meant to blend in the viewer's eye.

Seurat's most famous painting, *Sunday Afternoon on the Island of La Grande Jatte* (1886), is one of his first Pointillist works. It is reproduced in the Painting article. It shows a Sunday afternoon crowd on an island in the Seine River north of Paris, where middle-class people, working-class people, and prostitutes mingle. Seurat showed these people standing, walking, sitting under trees, fishing, or boating, but the painting gives an overall impression of stillness and suspended motion. Seurat carefully planned the painting's composition. The forms of the figures are large and simplified, showing little texture or facial detail. Instead, Seurat focused his attention on the observation of light and color.

Seurat's most frequent subjects were the entertainments of Paris and its suburbs. He also painted seascapes in Normandy each summer between 1885 and 1889, using Pointillism to describe the effect of light on the landscape and water.

Seurat was born in Paris. In 1876, he began his exploration of optical formulas for painting. His first major work, *A Bathing Place, Asnières,* was shown at the first Salon des Indépendants exhibition in 1884. At this exhibition, Seurat met the French painter Paul Signac, with whom he developed Pointillism in 1885 and 1886. Seurat died at the age of 31 of a sudden illness, possibly meningitis. Ann Friedman

See also Painting (Postimpressionism); Postimpressionism (picture).

Seuss, *soos,* **Dr.** (1904-1991), was the pen name of Theodor Seuss Geisel, an American writer and illustrator. Dr. Seuss was best known for his books for children. These works combine delightful nonsense, humorous drawings, and social commentary.

Most of Dr. Seuss's books are written in original comic verse and are illustrated by him. These works include *And to Think That I Saw It on Mulberry Street* (1937), *The 500 Hats of Bartholomew Cubbins* (1938), *How the Grinch Stole Christmas* (1957), *The Cat in the Hat* (1957), *Hop on Pop* (1963), *The Butter Battle Book* (1984), and *Oh, the Places You'll Go!* (1990). Dr. Seuss wrote and illustrated *You're Only Old Once!* (1986) for adults. Young readers enjoy his clever rhymes, drawings of fantastic creatures, and silly names and invented words. In 1984, the Pulitzer Prize Board awarded Dr. Seuss a Special Citation "for his contribution over nearly half a century to the education and enjoyment of America's children and their parents."

Theodor Seuss Geisel was born in Springfield, Massachusetts. He received no formal training in art, and he wrote and illustrated his first book to amuse himself. Nancy Lyman Huse

Sevastopol, *suh VAS tuh POHL* (pop. 361,000), lies on the Black Sea in the Crimean Peninsula in Ukraine. For the city's location, see Ukraine (political map). Sevastopol has a large harbor and port facilities. The 11-month siege of the city in 1854 and 1855 marked the chief battle of the Crimean War. Sevastopol was attacked again in 1918, during World War I. An eight-month siege in 1941 and 1942, during World War II, reduced Sevastopol to ruins, but the city has been largely rebuilt. Roman Szporluk

Seven Cities of Cíbola. See Cíbola, Seven Cities of.

Seven Natural Wonders of the World is a listing of outstanding natural features of the earth. Teachers use such listings to introduce students to the study of earth science. Listings of wonders also help us appreciate the great variety of the earth's landscape. Factors considered in making up a list include a feature's geographic character and geological importance, and its popularity with tourists. Various listings include different features. However, a majority of earth scientists probably would list most of the following.

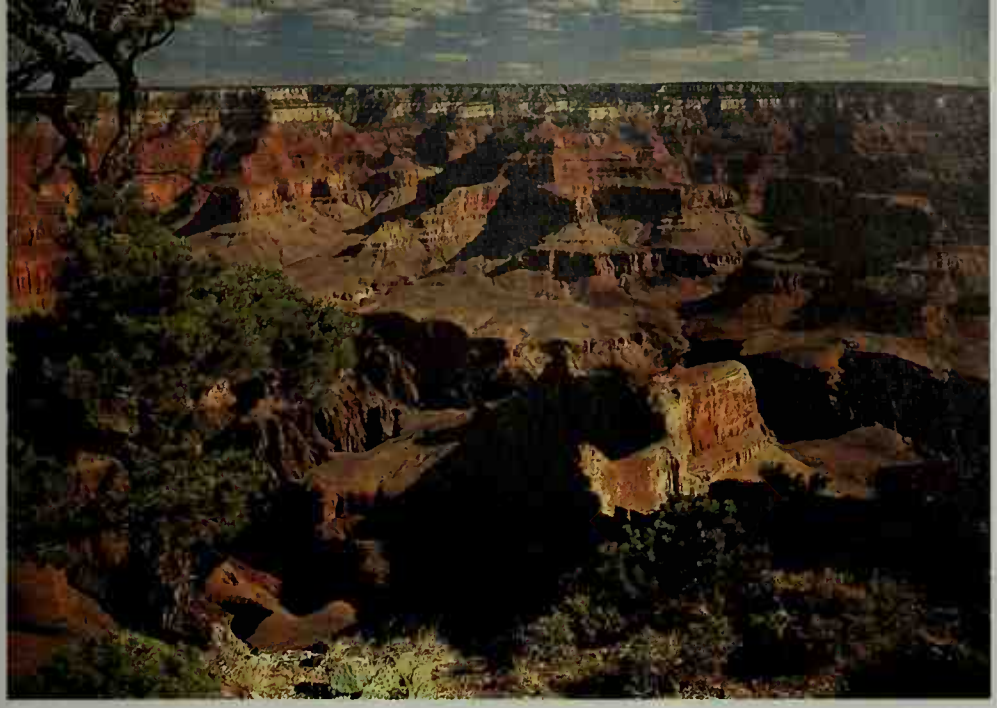
The Grand Canyon, in the United States, is a breathtaking feature created by the *erosion* (wearing away) of rock by the Colorado River over a period of about 6 million years. The canyon extends across northwestern Arizona for 277 miles (446 kilometers), and is about 1 mile (1.6 kilometers) deep. The erosion exposed rock formations that represent 1 $\frac{3}{4}$ billion years of earth's history. The flow of the river, and thus the rate of erosion, has been reduced by the construction of the Glen Canyon Dam upstream from the Grand Canyon.

Mount Everest, rising 29,035 feet (8,850 meters) above sea level, is the world's highest mountain. It stands on the border of Nepal and Tibet in a massive range called the Himalaya. This range formed in a gradual collision of 2 of the approximately 30 *tectonic plates* that make up the earth's outer shell. One plate folded like a tablecloth that is pushed across a table. The highest "wrinkle" is the Himalaya. The range is still rising about 1 centimeter each year.

Ayers Rock is the world's largest *monolith* (single

Seven Natural Wonders of the World

Remarkable features of the earth's surface have been listed as natural wonders because they are imposing to the eye and are striking examples of how natural forces shape the landscape. The photographs on this page and the following page show seven features that are commonly listed as natural wonders.



Josef Muench

The Grand Canyon is a valley that is about 1 mile (1.6 kilometers) deep.

Dave Bartruff, FPG

Mount Everest is the world's highest mountain.

Ayers Rock is the largest single stone on earth.

Michael Fogden, Earth Scenes

© Chris Bonington, Bruce Coleman Collection.

The Matterhorn is known for its pyramidal shape.

© Meteor Crater Enterprises

Meteor Crater formed when a meteorite fell to earth.

© Mark Boulton, Bruce Coleman Inc.

Victoria Falls is about 1 mile (1.6 kilometers) wide.

© Andrew N. Drake

The Great Barrier Reef is the longest group of coral reefs.

large stone). It rises 1,142 feet (348 meters) above the desert floor in central Australia. The rock is loaf-shaped and has a circumference of about 5 $\frac{1}{2}$ miles (9 kilometers). It is composed of red sandstone. Its name is *Uluru* in the language of Australia's Aborigine people.

The Matterhorn is one of the most beautiful mountains on earth. Its base is in Switzerland and Italy. Its peak, in Switzerland, is 14,692 feet (4,478 meters) above sea level. The Matterhorn is known for its extraordinary pyramidal shape, called a *horn* by earth scientists. Glaciers formed the horn by eroding rock from a mountain as they pushed inward from opposite sides.

Victoria Falls is a waterfall on the Zambezi River in southern Africa, between Zimbabwe and Zambia. At the falls, the river is about 1 mile (1.6 kilometers) wide. The falls plunges 355 feet (108 meters) into a gorge. The local name of the falls, *Mosi oa Tunya* (smoke that thunders), describes its tremendous sound and the water vapor that rises from the falls.

Meteor Crater, also known as Barringer Crater, is a huge circular depression in the ground near Winslow, Arizona. It formed when a meteorite struck the earth about 50,000 years ago—a recent event in geological history. The crater is 570 feet (175 meters) deep and 4,180 feet (1,275 meters) wide. Scientists consider it the best crater of its kind on earth because it was created so recently. It is in almost perfect condition.

The Great Barrier Reef is the world's longest group of coral reefs. It follows the coast of Australia for about 1,400 miles (2,300 kilometers). The reef consists of small islands of solid coral, patches of coral sand, and submerged coral. Coral is made up of hardened skeletons of water animals called *polyps* that have died. But billions of live polyps are attached to submerged coral. Living polyps and other animals give undersea parts of the Great Barrier Reef a brilliant coloring. Many people are concerned about possible damage to the reef by the large number of tourists who visit it. Paul D. McDermott

Related articles in *World Book.* For information on other outstanding natural features, see *Related articles* **Desert, Lake, Mountain, River,** and **Waterfall.** See also:

Grand Canyon	Matterhorn	Mount Everest
Great Barrier Reef	Meteor Crater	Victoria Falls

Seven seas is an ancient term describing all the seas and oceans of the world. Many people believe the seven seas referred to are the Arctic, North and South Pacific, North and South Atlantic, Indian, and Southern (sometimes called Antarctic) oceans. However, the phrase has no literal meaning, and it came into use before some of the oceans were even known to exist.

Seven Weeks' War, also called the Austro-Prussian War, took place between June and August of 1866. Austria and most of the German states fought against Prussia and Italy. Otto von Bismarck, prime minister of Prussia, used the Seven Weeks' War as part of his campaign to force Austria out of the German Confederation. He also used the war to make Prussia the dominant power in Germany.

A dispute over the former Danish duchies of Schleswig and Holstein furnished the immediate cause of the war. Austria, joined by the German states of Hesse, Saxony, and Hanover, declared war on Prussia on June 14, 1866. Bismarck secured the help of Italy. Bismarck also helped persuade France to stay neutral by implying

vaguely that France would be given new territory if Prussia won the war.

The Prussian army was outnumbered. However, it had a brilliant leader in General Helmuth von Moltke. His skillful use of new railroads and such new inventions as the fast-firing "needle gun" and the telegraph enabled the Prussians to win a series of quick victories. The greatest of these victories was the crushing defeat of the Austrians at the Battle of Königgrätz (also called Sadowa) on July 3.

The peace treaty ending the war was signed in Prague on August 23. According to the terms of the treaty, Austria had to give Venetia to the new Kingdom of Italy and was also required to pay a small amount of money to Prussia. In addition, Austria was excluded from German affairs, and it was never again a power in Germany. The treaty also dissolved the old German Confederation, and permitted Prussia to organize its own North German Confederation in 1867. Prussia dominated the new confederation. Prussia also annexed Schleswig-Holstein, the German state of Hesse-Kassel, the Kingdom of Hanover, the Duchy of Nassau, and the free city of Frankfurt. Charles W. Ingrao

See also **Bismarck, Otto von; Germany** (History [The unification of Germany]); **Moltke, Helmuth Karl von.**

Seven Wonders of the Ancient World is a listing of notable objects built between about 3000 B.C. and A.D. 476. The practice of listing the seven wonders probably began in ancient Greece. The ancient Romans also listed memorable things that travelers should see. Many such lists were made, and they included many different objects. But all the lists of ancient wonders included only objects made by human beings and considered notable because of their great size or some other unusual quality. This article discusses the seven most commonly listed wonders of the ancient world.

The pyramids of Egypt at Giza, built as tombs for Egyptian kings, are the oldest and best preserved of all the ancient wonders. Three famous pyramids there were built about 2600 to 2500 B.C. The largest pyramid, called the Great Pyramid, stands about 450 feet (137 meters) high. Its base occupies about 13 acres (5 hectares). The Greeks and Romans marveled at the size of the pyramids. They were unaware of the religious importance of the pyramids as tombs, and considered the pyramids to be foolish extravagances of the Egyptian kings. See **Pyramids.**

The Hanging Gardens of Babylon were probably built by King Nebuchadnezzar II for one of his wives. Nebuchadnezzar ruled Babylon from 605 to 562 B.C. Babylon was located near modern Baghdad in Iraq. Scientists have been unable to identify positively the remains of the gardens. Our information about the gardens comes from an account by Berossus, a Babylonian priest of the 200's B.C. Berossus described gardens that were laid out on a brick terrace about 400 feet (120 meters) square and 75 feet (23 meters) above the ground. In order to irrigate the flowers and trees in the gardens, slaves worked in shifts turning screws to lift water from the Euphrates River.

The Temple of Artemis at Ephesus, built about 550 B.C., was one of the largest and most complicated temples built in ancient times. It stood in the Greek city of Ephesus, on the west coast of what is now Turkey. The temple was entirely marble, except for its tile-covered wooden roof. It was dedicated to the Greek goddess Artemis and was designed by the architect Chersiphron and his son, Metagenes. Its foundation measured 377 by 180 feet (115 by 55 meters). It had 106 columns, about 40 feet (12 meters) high, in a double row around the *cella* (inner space). Wealthy King Croesus of Lydia donated some of the columns.

The temple burned down in 356 B.C., and another one like it was built on the same foundation. Goths burned down the second temple in A.D. 262. Only the foundation and parts of the second temple remain. The British Museum in London contains sculptures from the second temple.

The statue of Zeus at Olympia, Greece, was perhaps the most famous statue in the ancient world. The Greek sculptor Phidias made it about 435 B.C., and dedicated it to Zeus, the king of the gods. The statue, 40 feet (12 meters) high, showed Zeus on his throne. Phidias made Zeus's robe and ornaments out of gold, and he made the god's flesh of ivory. In the statue, Zeus had a wreath around his head and held a figure of Nike, his messenger, in his right hand. He held a *scepter* (king's rod) with an eagle in his left hand. The statue no longer exists. See **Phidias.**

The Mausoleum at Halicarnassus, in what is now southwestern Turkey, was a huge, white marble tomb. It was built about 353 B.C. to hold the remains of Mausolus, a provincial ruler in the Persian Empire. Its size and decorations made it so famous that all large tombs are now called *mausoleums.* The tomb was about 135 feet (41 meters) high. It had a rectangular basement beneath a colonnade formed by 36 columns. A stepped pyramid rested on the colonnade, and a statue of Mausolus in a chariot probably stood on top of the pyramid. The Greek architects Satyros and Pythios designed the tomb. Four famous Greek sculptors—Bryaxis, Leochares, Scopas, and Timotheus—carved the *frieze* (decorated band) on the building. The top part of the mausoleum was destroyed by an earthquake, and only pieces of the building and its decorations remain. The British Museum in London contains some sculptures from the mausoleum.

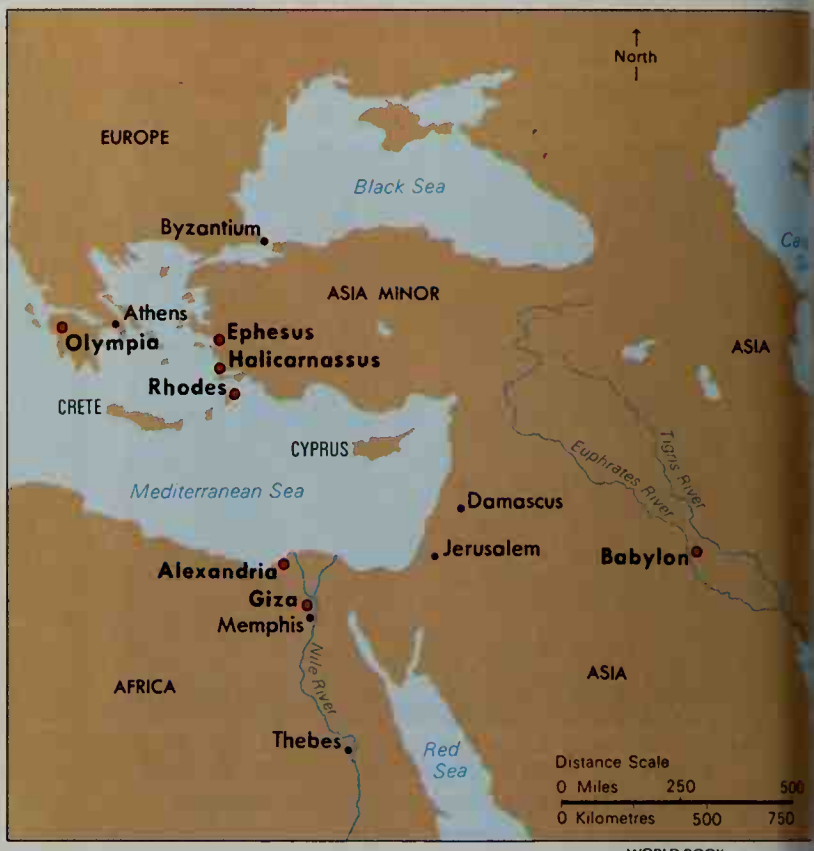
The Colossus of Rhodes was a huge bronze statue that stood near the harbor of Rhodes, an island in the Aegean Sea. The statue honored the sun god Helios. It stood about 120 feet (37 meters) tall—about as high as the Statue of Liberty. The Greek sculptor Chares worked 12 years on it in the early 200's B.C. He used stone blocks and about $7\frac{1}{2}$ short tons (6.8 metric tons) of iron bars to support the hollow statue. In 224 B.C., the Colossus was destroyed by an earthquake. The metal supports were sold for scrap in A.D. 653.

The Lighthouse of Alexandria, over 400 feet (122 meters) high, stood on the island of Pharos in the harbor of Alexandria, Egypt. It became so famous that the word *pharos* came to mean *lighthouse.* The lighthouse is also called the Pharos of Alexandria. The structure, completed during the reign of Ptolemy II (283-246 B.C.) from a design by the Greek architect Sostratos, rose from a stone platform in three sections. The bottom section of the lighthouse was square, the middle eight-sided, and the top circular. A fire burning at the top of the lighthouse provided light. The Lighthouse of Alexandria

Seven Wonders of the Ancient World

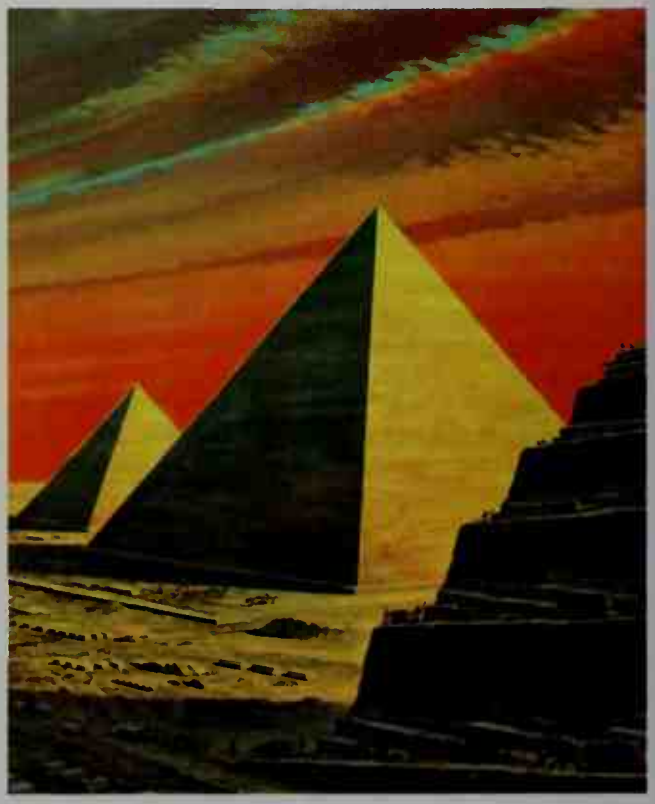
Ancient Greeks and Romans made up many lists of notable objects. These illustrations show the objects that have been most commonly listed as the Seven Wonders of the Ancient World. The map, *below right,* shows the location of the Seven Wonders of the Ancient World in red.

The Temple of Artemis at Ephesus was one of the largest temples built by the Greeks. It was famous for its decoration and extensive use of marble.



WORLD BOOK map

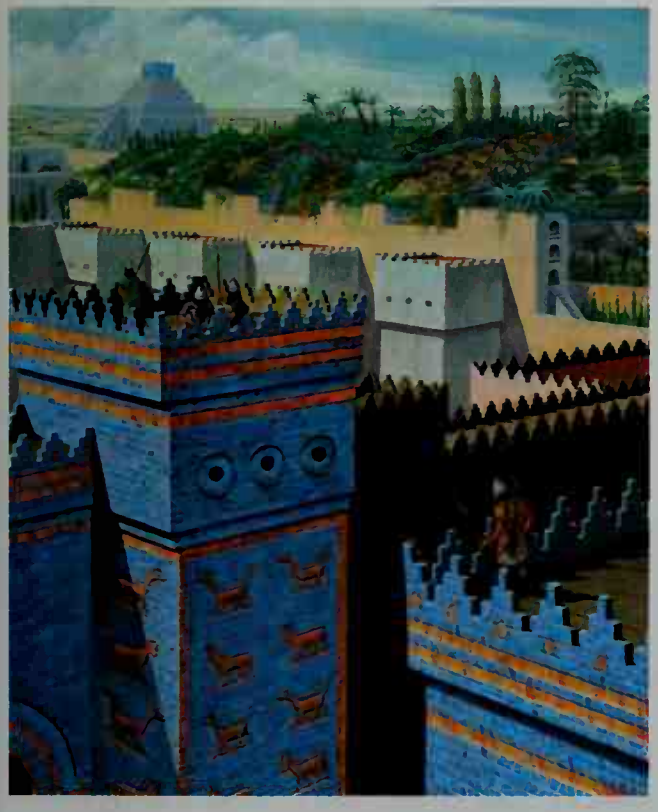
The statue of Zeus at Olympia, Greece, was probably the most famous statue made by the Greeks. People who came to watch the Olympic Games admired this gold and ivory figure.



The pyramids of Egypt at Giza are the best preserved of the Seven Wonders of the Ancient World. They still attract many visitors to Giza, just outside the present-day city of Cairo.

The Lighthouse of Alexandria, Egypt, was the world's first important lighthouse. It guided ships into the city's harbor for about 1,500 years before being toppled by an earthquake.

The Mausoleum at Halicarnassus was a great marble tomb. It was built for Mausolus, a local ruler, by some of the most famous Greek sculptors and architects.



The Hanging Gardens of Babylon probably were built by King Nebuchadnezzar II after he married a mountain princess. He apparently hoped the gardens would make her feel at home.

WORLD BOOK illustrations by Birney Lettick

The Colossus of Rhodes was built in honor of the sun god Helios. It was constructed after the people of Rhodes survived a yearlong siege by a large force of Macedonians.

stood for about 1,500 years before it was finally toppled by an earthquake. William P. Donovan

Seven Years' War (1756-1763) involved nearly every nation in Europe, and extended to America and India. In America, it was called the French and Indian War. In Europe, Prussia and Austria fought each other for control of Germany. Britain aided Prussia, and France helped Austria. Britain battled France for control of the seas and territories in North America. As a result of the Seven Years' War, France lost its North American empire to Britain.

In Europe. The Seven Years' War resulted from the desire of Maria Theresa, ruler of Austria, to recover possession of the province of Silesia from Frederick the Great, king of Prussia. Frederick had taken most of Silesia from Austria, but Maria Theresa never gave up hope of regaining it. She allied herself with Czarina Elizabeth of Russia, who bitterly hated and feared the Prussian king. Maria Theresa found it more difficult to make an alliance with France, Austria's ancient enemy. She finally succeeded with the aid of her shrewd foreign minister Wenzel Anton von Kaunitz. He was aided by an agreement between Britain and Prussia. This agreement alarmed the French, who saw it as an act of treachery by Frederick the Great, their ally.

Meanwhile, Frederick the Great was carefully watching the moves of his enemies. He was determined to strike the first blow. In August 1756, Frederick invaded the German state of Saxony because it was an ally of Austria, wealthy, and strategically located. Frederick soon forced the entire Saxon army to surrender and took control of the state.

In spite of these gains, Prussia's hopes for victory were dim early in 1757. Austria, France, Russia, Sweden, and most of the German states were united against the Prussian king. Britain, Prussia's only ally, gave little help. But Frederick moved with great vigor and decision. In November 1757, he destroyed the French in a great battle at Rossbach in Saxony. A month later, he defeated the Austrians at Leuthen, in Silesia.

In 1758, William Pitt, Britain's secretary of state, began to give more active aid to Prussia. The British organized a new army, and it defeated French forces several times.

But Frederick's resources were limited, and his costly campaigns had weakened Prussia. Prussia was near exhaustion and seemed to face almost certain ruin. But Frederick's enemies failed to develop a joint plan against him. In 1762, Elizabeth of Russia died and was succeeded by Peter III. Peter, an enthusiastic admirer of Frederick, concluded a separate peace with Prussia. This turn of fate saved Frederick.

By terms of the peace signed in Hubertusburg early in 1763, most of Silesia remained under Prussian rule, and other boundaries stayed as they had been before the war. There were no territorial changes in Europe. The Treaty of Paris settled disputes between France, Spain, and Britain on Feb. 10, 1763.

In America. One of the main results of the Seven Years' War took place far from Europe. Britain finally won its long struggle with France for the control of North America. At the end of the war, France gave up almost all its lands in North America to Britain, and also gave up its empire in India. For a history of the war in America, see **French and Indian wars.** Charles W. Ingrao

Related articles in *World Book* include:
Frederick II (of Prussia)
Maria Theresa
Pitt, William
Pompadour, Marquise de
Silesia

Seventh-day Adventists, *AD vehn tihsts,* are a Christian religious denomination. Adventists believe that Christ will return in person. They also believe that at death the breath of God—the energy for life—returns to the Creator while the body rests in the grave awaiting the resurrection at Jesus Christ's Second Coming. Adventists observe the Sabbath on Saturday, the seventh day of the week.

Adventists originated in the early 1800's, when many people in America and Europe became absorbed in the doctrine of Christ's Second Coming. References in the Bible that seemed to prophesy the time of Christ's coming aroused their interest. Followers of William Miller, a Baptist minister, predicted a definite time for the coming, but his interpretation proved wrong. One group restudied Bible prophecies. It decided that what had happened was the beginning of the judgment in heaven that is to precede the Second Coming of Christ. This group formed in 1863 as the Seventh-day Adventists.

The denomination has about 6 million members throughout the world, including over 700,000 in the United States and Canada. Its international headquarters are in Silver Spring, Maryland.

Critically reviewed by the Seventh-day Adventists

See also Adventists.

Severn, *SEHV uhrn,* **River,** is Great Britain's longest river and one of the island's chief waterways. It rises in central Wales and winds 220 miles (354 kilometers) through England to the Bristol Channel. The Severn Bridge crosses the river at Beachley. Used by motor vehicles, it is one of the world's longest suspension bridges. A railroad from London to Wales uses a 4-mile (6.4-kilometer) tunnel under the river's mouth. Canals connect the Severn with the Trent, Thames, and Mersey rivers. Huge, destructive waves called *tsunamis* often flood the banks of the Severn Estuary. M. Trevor Wild

Sevier, *see VEER,* **John** (1745-1815), was an American soldier, frontiersman, and politician. He served as governor of "The lost state of Franklin" and later became the first governor of Tennessee.

Sevier, the son of a tavernkeeper, was born on Sept. 23, 1745, near New Market, Virginia. He received little education, and as a young man supported himself by farming and trading. In 1773, he moved to the Holston River Valley, then an unsettled region of the colony of North Carolina. It is now in eastern Tennessee.

Sevier actively supported the Revolutionary War but fought little until 1780. That year, he led an expedition over the Smoky Mountains and helped defeat the British at Kings Mountain. Later, Sevier led an expedition against the Cherokee Indians in the first of many campaigns to bring him fame as an Indian fighter. After the Revolutionary War, settlers in Tennessee began a movement to make the region a separate state. In 1784, the state of Franklin was organized, and Sevier was elected governor in 1785. Indian troubles, land speculation plots, and quarrels with rivals led to his downfall and the practical end of the state of Franklin in 1788. Sevier was later elected to the North Carolina Senate. From 1789 to 1791 he served in the federal Congress.

In 1796, "The lost state of Franklin" became part of Tennessee. Sevier was elected its first governor and served six terms. After the end of his sixth term, Sevier was elected to the state senate for one term and then served again in Congress until his death. A statue of Sevier represents Tennessee in the Statuary Hall collection in the U.S. Capitol in Washington, D.C. Thomas D. Clark

See also Franklin, State of.

Seville, *suh VIHL* (pop. 659,126), is one of the leading centers of Spanish art, literature, and education. The city is also called Sevilla (pronounced *say VEEL yah*). Two of Spain's greatest painters, Diego Velázquez and Bartolomé Murillo, were born in Seville. Two famous operas, *Carmen* and *The Barber of Seville,* are set in the city. Legend says that Don Juan lived in Seville. The legend of Don Juan provided material for many writers and composers. The University of Seville dates back to 1502.

The city lies 60 miles (97 kilometers) northeast of Cádiz on the Guadalquivir River, in an area of vineyards and orange groves. For the location of Seville, see Spain (political map). A great wall with 64 towers once surrounded the city, and its remains still stand. Moors lived in Seville for hundreds of years. Moorish influence shows in the city's network of small, shaded streets and in the whitewashed, balconied houses built around courtyards and fountains.

Seville's greatest building is its cathedral, started in 1402 and finished in 1519. It stands on the site of a Moorish mosque, and is one of Europe's largest church structures. Only St. Peter's in Rome and the basilica in Lourdes, France, are larger. Some people think Christopher Columbus was buried in Seville's cathedral. But the Dominican Republic also claims to be his burial place. Seville's emblem is the *Giralda,* a Muslim minaret that is part of the city's cathedral. The Giralda stands over 300 feet (91 meters) high. It was built in the 1100's.

Seville's factories produce cigars, pottery, silks, machinery, chocolate, perfume, and iron products. Canals and the Guadalquivir River make the city an important inland port. Exports include wine, olives and other fruit, and cork, mercury, and wool. The city is the capital of Seville province.

In 1992, Seville hosted a world's fair called Expo '92. Held during the 500th anniversary year of Christopher Columbus' first voyage to the New World, the fair had the theme "The Age of Discoveries." Stanley G. Payne

Sèvres, *SEH vruh,* Treaty of, forced the defeated Ottoman Empire to give up much of its territory at the close of World War I. The treaty was signed on Aug. 10, 1920. It gave independence to parts of the empire and gave other parts to the British and other Allied powers.

Under the terms of the treaty, the United Kingdom received a *mandate* (order to rule) over what is now Israel, Jordan, and most of Iraq. France gained a mandate over what is now Syria and Lebanon. The Ottoman Empire was to give up all its territorial claims in northern Africa and to cede eastern Thrace to Greece. Parts of present-day western Turkey were to be under Greek rule for five years. The independence of Armenia was recognized after the United States refused a mandate over it. The waters around the Ottoman Empire were to be opened to the vessels of all nations, and the Ottoman armed forces were to be reduced to a police force. In addition, the treaty provided for Ottoman finances to be controlled by an Allied commission.

The treaty was signed by the Ottoman government but never ratified by Turkish nationalists. The nationalists, under the leadership of Kemal Atatürk, overthrew the Ottoman government, set up an independent state of Turkey, and drove the Greeks from what is now western Turkey. Atatürk then negotiated a new peace treaty with the Allies. It was signed at Lausanne, Switzerland, in 1923. The treaty set Turkey's borders about where they are today, but left the British in control of much of the former Ottoman Empire. Diane Shaver Clemens

See also Atatürk, Kemal; Versailles, Treaty of.

Sewage is water that contains waste matter produced by human beings. It is also called *wastewater.* It contains about a tenth of 1 percent solid matter. Sewage comes from the sinks and toilets of homes, restaurants, office buildings, and factories. It contains dissolved material that cannot be seen, plus bits of such solid matter as human waste and ground-up garbage. Some sewage may also contain ground and surface water runoff that occurs after storms or floods. Most sewage also includes harmful chemicals and disease-producing bacteria.

Most sewage eventually flows into lakes, oceans, rivers, or streams. In the United States, almost all sewage is treated in some way before it goes into the waterways as a semiclear liquid called *effluent.* Untreated sewage looks and smells foul, and it kills fish and aquatic plants.

Even treated sewage can harm water. For example, most methods used to treat sewage convert organic wastes into inorganic compounds called *nitrates, phosphates,* and *sulfates.* Some of these compounds may serve as food for algae and cause large growths of these simple aquatic organisms. After algae die, they decay. The decaying process uses up oxygen. If too much oxygen is used, fish and plants in the water will die.

A system of pipes that carries sewage from buildings is called a *sanitary sewerage system.* There are two main types of sanitary sewerage systems: (1) urban sewerage systems and (2) rural sewerage systems.

Urban sewerage systems

In the United States, treatment of sewage is regulated by the Clean Water Act of 1972 and its amendments. In most U.S. cities and towns, sewage from homes and other buildings flows into a public sewerage system. Many industries operate their own wastewater treatment facilities. Other industries partially treat the sewage and then discharge it into a public sewerage system. In some cases, industrial wastewater flows untreated into waterways.

In a public sewerage system, the largest sewers, called *interceptors,* carry the sewage to a *wastewater treatment plant.* Sewage treatment in most cities involves two main steps, *primary* and *secondary* treatment. Some cities also require a step called *tertiary* (third) treatment.

Primary treatment removes the heaviest solid material from sewage. At a treatment plant, sewage first passes through a screen that traps the largest pieces of matter. It then flows through a *grit chamber,* where heavy inorganic matter, such as sand, settles. The liquid next flows into a large *primary sedimentation tank.* Many suspended solids sink to the bottom of this tank and form a muddy material called *sludge.* Grease floats to

the surface, where it is removed by a process called *skimming*. The effluent is then released into waterways.

Primary treatment removes about half the suspended solids and bacteria in sewage. Sometimes a gas called *chlorine* is added after primary or secondary treatment to kill most of the remaining bacteria. Primary treatment removes about 30 percent of the organic wastes. When the remaining organic wastes are discharged into waterways, bacteria break them down and thus continue the process of purifying the wastewater. The breaking-down process uses up oxygen in the water. See **Water pollution** (Effects).

Secondary treatment removes from 85 to 90 percent of the solids and oxygen-consuming wastes remaining in sewage after it has undergone primary treatment. The most common methods of secondary treatment are (1) the activated sludge process and (2) the trickling filtration process.

The activated sludge process. In this process, effluent from the primary sedimentation tank flows into a second tank called an *aeration tank*. Air is injected into this tank in a bubbling action. Sludge containing useful bacteria is also in the tank. The useful bacteria move through the liquid and change the organic matter into less harmful substances. Next the liquid flows into a *final sedimentation tank,* where the sludge settles to the bottom. The effluent is then discharged into waterways. Part of the sludge is recycled into the aeration tank.

The trickling filtration process. Trickling filters are tanks filled with crushed rocks. As sewage is distributed over the rocks, it reacts with slime that develops on the rocks. The slime contains useful bacteria that change organic material in the sewage into less harmful substances. These substances are removed in a final sedimentation tank, where they fall to the bottom as sludge.

Sludge resulting from primary and secondary treatment is pumped to a *sludge digestion tank*. In this tank, bacteria break the sludge down into less harmful substances producing methane gas, a useful fuel. Digested sludge may be dried for use as fertilizer or burned.

Tertiary treatment is used after primary and secondary treatment to produce purer effluent. There are various methods of tertiary treatment. The method a community chooses depends on (1) what substances are present in its raw sewage and (2) how the effluent will be used. Tertiary treatment methods include biological nutrient removal, chemical treatment, microscopic screening, radiation treatment, and the discharge of the effluent into lagoons.

Tertiary treatment makes effluent safer to discharge into waterways and safer for industry to use. Few treatment plants in the United States use all three methods of treatment—primary, secondary, and tertiary. However, many states are working with local communities to improve sewage treatment methods.

Rural sewerage systems

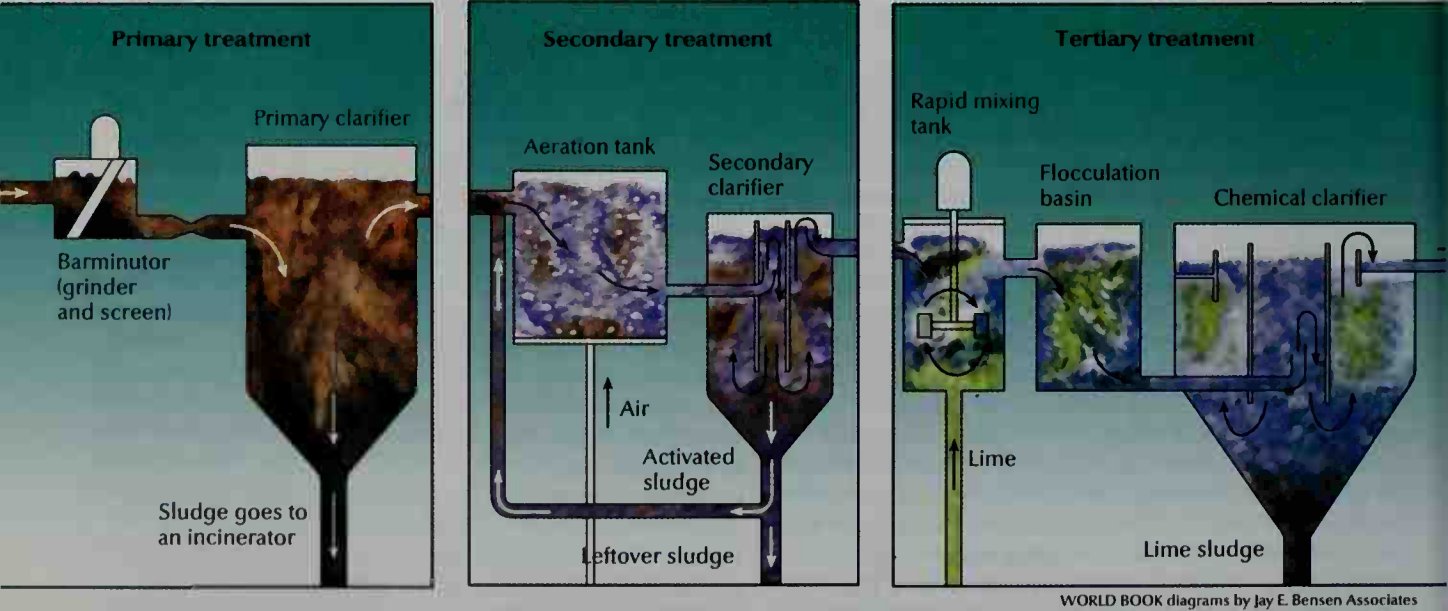
Many rural areas are not served by public sewers. In such areas, most homeowners use *septic tanks* to treat their sewage. These tanks are concrete or steel containers buried underground at homes and buildings.

Sewage flows into a septic tank through a pipe connecting the tank with a building. Solids in the sewage sink to the bottom of the tank as sludge or float to the surface as scum. Effluent then flows from the tank into a *leaching field,* a system of pipes with open joints that allows sewage effluent to be gradually distributed into the soil. Soil bacteria then destroy the remaining organic material in the effluent.

In a septic tank, bacteria in the sewage attack and di-

A modern sewage treatment plant

The South Lake Tahoe, California, sewage treatment plant, *diagramed here,* provides primary, secondary, and tertiary sewage treatment. South Lake Tahoe uses a method of secondary treatment called the *activated sludge process.* It is one of only a few U.S. cities that provide tertiary treatment.



WORLD BOOK diagrams by Jay E. Bensen Associates

Primary and secondary treatment remove up to 95 percent of the waste in sewage. In primary treatment, the largest solids are ground up and settle in a clarifier. In secondary treatment, bacteria further purify the effluent in an aeration tank, and sludge is removed in another tank.

Tertiary treatment removes even more impurities from the effluent. First, the effluent is mixed with lime, which causes particles of matter to *floc* (bunch together) and settle in a clarifier.

gest the sludge and scum. This *digestion* process changes most of the wastes into gas and a harmless substance called *humus.* The gas escapes into the air. The humus in the tank must be pumped out periodically and taken to a sewage treatment plant. Melody J. Hunt

See also **Plumbing; Water pollution.**

Additional resources

Coombs, Karen. *Flush! Treating Wastewater.* Carolrhoda, 1995. Younger readers.

Kahn, Lloyd, and others. *Septic System Owner's Manual.* Shelter, 2000.

Sewall, *SOO uhl,* **Arthur** (1835-1900), was the Democratic candidate for vice president of the United States in 1896. He and presidential candidate William Jennings Bryan lost to Republicans William McKinley and Garret A. Hobart. Sewall was a Maine shipbuilder, banker, and railroad executive. He owned, built, and operated more sailing vessels than any other American between 1850 and 1900. Sewall supported the income tax and favored *free silver,* a plan to coin unlimited amounts of silver. He was born in Bath, Maine, on Nov. 25, 1835.

Edward A. Lukes-Lukaszewski

Sewall, *SOO uhl,* **Samuel** (1652–1730), was a judge at the famous Salem witchcraft trials in the Massachusetts Bay Colony in 1692. As a result of those trials, 19 people were convicted of witchcraft and hanged (see **Salem witchcraft trials**). Sewall later regretted the court's action. In 1697, he made a public confession of error and guilt for his part in the trials.

Sewall was born on March 28, 1652, in Bishopstoke in Hampshire County, England. His family moved to New England when he was 9 years old. In 1671, Sewall attended Harvard College and received a bachelor's degree in 1671 and a master's degree in 1674. He became a minister and, later, a merchant. Sewall also served in the colony's legislature and as a justice in the courts. He was concerned with the American Indians' fate, and he opposed slavery. He wrote many books, including a diary that was a classic of colonial literature. Pauline Maier

Seward, *SOO uhrd,* **William Henry** (1801-1872), served as United States secretary of state during the Civil War (1861-1865). He was the leading Republican in the nation in 1860, but Abraham Lincoln defeated him for the party's nomination. Seward worked for Lincoln's election and entered his Cabinet as secretary of state. Because of Seward's able administration of foreign affairs, European countries did not aid the Confederacy. He was wounded by an accomplice of John Wilkes Booth on the night that Lincoln was assassinated. He slowly recovered and continued as secretary of state under President Andrew Johnson.

Important tasks that Seward accomplished included the purchase of Alaska from Russia in 1867. At that time, the purchase was mockingly called "Seward's Folly" and "Seward's Icebox." See **Alaska** (American purchase).

Seward was born on May 16, 1801, in Florida, New York. He attended Union College in Schenectady, New York. He became a lawyer in 1822. Seward won election to the state legislature in 1830 and joined the Whig Party about 1834 (see **Whig Party**). He was governor of New York from 1839 to 1842 and became a U.S. senator in 1849. Seward opposed slavery and fought its spread.

Mark E. Neely, Jr.

See also **Johnson, Andrew** (Foreign relations); **Lincoln, Abraham** (Election of 1860; Foreign relations); **Trent Affair; Emancipation Proclamation** (picture); **State, Department of** (picture).

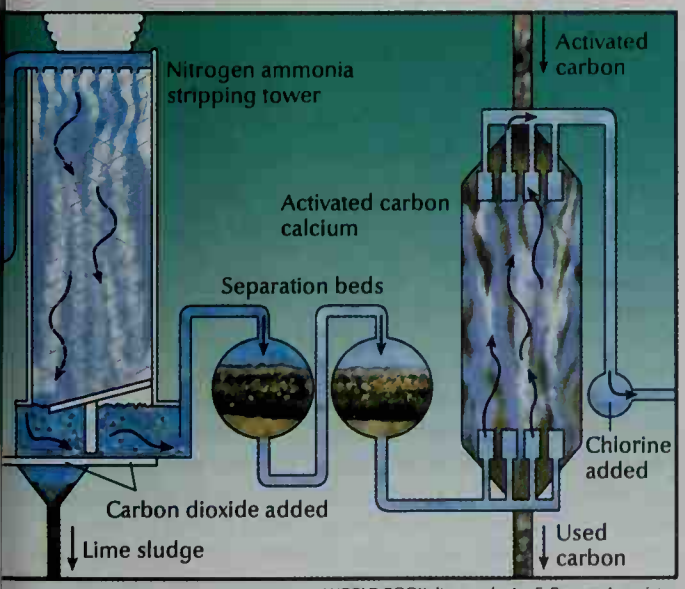
Sewell, *SOO uhl,* **Anna** (1820-1878), wrote *Black Beauty* (1877), a novel about a horse that becomes injured and suffers abuse from a series of owners. The book, which became extremely popular, is a moral tale about the cruel treatment of horses. The Society for the Prevention of Cruelty to Animals promoted *Black Beauty,* contributing greatly to the book's success.

Mary Evans Picture Library

Anna Sewell

Sewell was born on March 30, 1820, in Yarmouth, England, on the Isle of Wight. At the age of 14, she sprained both her ankles. The injury was probably treated incorrectly, and Anna was crippled for the rest of her life. Her greatest mobility was on horseback or in driving a pony and carriage. Sewell was an invalid during the six years she wrote *Black Beauty,* her only book. Her mother, Mary Sewell, a children's author, helped Anna by copying the manuscript. Kathryn Pierson Jennings

Sewing is the process of stitching pieces of fabric together with a needle and thread, by hand or using a sewing machine. Many people enjoy sewing their own clothes and such household articles as bedspreads, pillows, curtains, and slipcovers. Clothing and other items sewn at home may cost less, fit and wear better, and have more individuality than ready-made products.



WORLD BOOK diagram by Jay E. Bensen Associates

The process continues as the effluent enters a stripping tower, where nitrogen and ammonia are released. The effluent is mixed with carbon, which removes the tiniest bits of organic matter. Finally, chlorine is added to kill most of the bacteria.

Sewing also plays a vital role in the clothing, home furnishings, and textile industries.

People in western Europe and central Asia began to sew, using bone needles, more than 17,000 years ago. Most sewing was done by hand until the 1800's. In 1846, an American inventor named Elias Howe patented the first practical sewing machine. Today, most sewing is done by machine.

Kinds of stitches

Many kinds of stitches can be used in sewing. The kind used depends on whether the sewing is done by hand or by machine.

Hand stitches. There are six main hand stitches: (1) the running stitch, (2) the basting stitch, (3) the slipstitch, (4) the blindstitch, (5) the overcast stitch, and (6) the catchstitch.

The running stitch is used for *gathering,* pulling the fabric together into small folds. These folds, called *gathers,* add fullness to necklines, sleeves, and waistlines.

The basting stitch is a temporary stitch that holds two or more pieces of fabric together. Basting stitches serve as a guide for permanent machine stitching.

The slipstitch provides an invisible finish when permanently attaching flaps, linings, and pockets to a garment. It is used on folded edges because the lengths of thread can be concealed within the folds.

The blindstitch holds hems and *facings* in place. Facings are pieces of fabric that cover edges of a garment. This technique keeps the stitches from showing.

The overcast stitch is a slanted, evenly spaced stitch used on the *raw* (cut) edges of a seam. Overcasting prevents the edges from fraying.

The catchstitch is a flexible stitch used to hold two layers of fabric together. It is often used to secure hems in knit garments.

Machine stitches include *straight, zigzag,* and *decorative* stitches. Straight stitches are used for basting and gathering and for sewing seams. Zigzag stitches may be used for finishing raw edges, making buttonholes, or attaching elastic to a garment. Attachments, dials, or levers on some machines can be set to produce decorative stitches.

Preparing for a sewing project

Choosing the equipment, fabric, and pattern. In addition to a sewing machine, sewing requires five basic groups of equipment: (1) hand sewing equipment, including a needle and thread; (2) marking tools, such as chalk or pins; (3) a tape measure or other measuring tools; (4) scissors; and (5) an iron and ironing board. The proper equipment is essential for successful sewing.

Sewers may work with a wide variety of fabrics. Some fabrics, including cotton, linen, silk, and wool, are made from plant or animal fibers. Other fabrics consist of manufactured fibers, sometimes called *synthetics.* They include polyester, nylon, and rayon. See **Textile** (Sources of textile fibers).

Beginning sewers should avoid plaid or striped fabrics or those with a *nap.* Napped fabrics have soft, short threads on the surface. Plaid, striped, and napped fabrics require extra skill and time to cut out and sew. The design of plaid or striped fabrics should be matched at the seams. Napped fabrics, such as corduroy and velvet, must be laid out so that the nap runs in the same direction on all the pieces.

Cotton-covered polyester thread can be used for most sewing tasks. Fabrics made from certain synthetic fibers require the use of a synthetic thread. Fabrics made with natural fibers with little or no stretch may be sewn with *mercerized* cotton thread. Mercerization is a chemical treatment that increases the luster and strength of thread. Silk thread should be used to sew silk fabrics.

Only highly experienced sewers design their own patterns. Most people select patterns from catalogs. Most such catalogs have patterns for sewers of varying skill levels, including easy-to-sew patterns for beginners.

A pattern consists of pieces of paper shaped like the various sections of a garment, plus sewing instructions. Information printed on the pattern envelope suggests suitable fabrics. It also indicates the amount of material required and the necessary *notions* (such items as buttons and zippers). Generally, several different garments can be made from one pattern. A layout guide tells which pattern pieces to use for each garment.

Fitting the pattern. Patterns are made to fit general figure types and sizes. The pattern pieces have markings that indicate where to shorten or lengthen the pattern, if necessary. More extensive adjustments may require adding inserts or making tucks in the pattern pieces.

Laying out the pattern. The layout guide shows how the pattern pieces should be arranged on the fabric for cutting. It also tells whether to cut the pieces in a single or double thickness of fabric. Most pieces should align with the *lengthwise grain*—that is, the vertical threads of the fabric. These threads run parallel to the *selvages,* the finished edges of the fabric. *Bias* pieces are laid out diagonally across the grain. Cutting with or across the grain affects how a garment will hang when worn.

After the pattern pieces are pinned to the fabric, the pieces are cut out along the cutting line of the pattern. All buttonhole locations, center markings, and *darts* (short, tapered folds that give a garment its shape) should be marked on the fabric using chalk, pins, or a *tracing wheel* and paper. A tracing wheel is a small wheel with a handle attached. It is used with *tracing paper,* or waxed carbon paper, to mark the fabric.

Sewing the item

Most patterns give step-by-step instructions for sewing a garment. The sewing process may include making seams, darts, fastenings, facings, linings, and hems.

Seams are the basic element in garment construction. Most seams are formed by sewing the right sides of two fabric pieces together. Seams are usually sewn $\frac{5}{8}$ inch (1.6 centimeters) from the edge with a straight machine stitch. The length and *tension* (tightness) of machine stitches can be adjusted using special dials. Most seams require a stitch length of 10 to 12 stitches per inch (4 to 5 per centimeter) and a medium tension setting. But stitch length and tension should be adjusted based on the type of fabric and seam. Incorrect tension may cause the seam to pucker or pull out. The sewer should use the settings recommended by the machine's guidebook.

When sewing curved seams, one section of fabric may be slightly longer than the other, and *easing* is necessary. When easing, the sewer keeps the longer sec-

tion uppermost and constantly adjusts the two pieces while stitching to match the markings and avoid gathers.

The edges of seams should be *finished* (treated to prevent fraying). The sewer may cut the edges with *pinking shears* (sometimes called *pinking scissors*), which trim the edges in small scallops, or overcast the edges by hand or machine.

Some sewers make seams using a machine called a *serger*. This machine sews the seam, finishes the edges, and trims the fabric at the same time.

Darts are placed at the shoulders, elbows, bustline, and waistline of a garment in order to shape the fabric to fit the body. To make a dart, the fabric is folded with right sides together along the center of the marked dart, and pinned. The dart is then basted and stitched from the wide end toward the point.

Fastenings include buttons, zippers, snaps, and hooks and eyes. Buttons are attached with small stitches. Buttonholes are made by hand with a buttonhole stitch or by machine with a zigzag stitch. *Bound buttonholes* are made with small folded strips of fabric. The strips are stitched to form "lips" around the opening.

Zippers are usually applied by the *slot* (also called *centered*) method, the *lapped* method, or the *fly-front* method. The method used is based on the garment and the location of the zipper. For example, the slot method might be used for a neckline zipper, the lapped method on a skirt, and the fly-front method on slacks.

In all three methods, the zipper opening is basted closed and the seam pressed open. The zipper is basted facedown over the seam on the inside. The sewer stitches around the zipper and then removes the basting. *Invisible zippers,* which look like seams from the outside, must be inserted using a special machine attachment. Zippers may be handsewn to garments made from such delicate fabrics as crepe, chiffon, or velvet.

Snaps or hooks and eyes are used to fasten neck and waistline openings. They are handsewn to the inside of the garment.

Facings finish off a garment's raw opening edges, such as necklines and armholes. *Self-facings* are extensions of the garment that form a fold at the opening edges. *Shaped facings* are separate pieces of fabric that are sewn along the edge and turned to the inside. Special fabric called *interfacing* may be used between the facing and the outer garment to add firmness.

Linings cover the inner surface of a garment. Lining pieces are stitched together and then sewn by machine or hand to the inside of the garment.

Hems are used on the bottom edges of garments and sleeves. First, the edge is finished. Then it is turned to the inside and sewn in place, usually by the slipstitch, blindstitch, or catchstitch.

Sue Morrow Parker

Related articles in *World Book* include:

Appliqué	Clothing	Scissors
Bookbinding	Crochet	Sewing machine
(Forming a book)	Embroidery	Textile
	Knitting	Thread
Button	Needle	Zipper

Additional resources

Betzina, Sandra. *Fabric Savvy.* Taunton Pr., 1999.
Moyes, Patricia. *Sewing Basics.* Taunton Pr., 1999.
Reader's Digest *Complete Guide to Sewing.* Rev. ed. Reader's Digest, 1995.
Vogue/Butterick Step-by-Step Guide to Sewing Techniques. 3rd ed. Butterick, 1998.

Sewing machine is a machine that uses a needle to bind materials together with thread. It has lightened household work and helped families to have better and less expensive clothing than they might otherwise have had. In factories, it has helped make possible the mass production of clothing.

Kinds of sewing machines. There are three main types of sewing machines for the home: (1) straight-stitch, (2) swing-needle, and (3) electronic. All three kinds of sewing machines are available in cabinet and portable models. In addition, they may have a *free-arm,* or *open-arm,* design for easier sewing around pant legs and sleeves.

Straight-stitch sewing machines are designed for simple sewing that requires no decorative stitching. Various attachments can be added to the machine to help make buttonholes, ruffles, and hems.

Swing-needle sewing machines, also called *zigzag sewing machines,* are designed for special stitching as well as straight stitching. The needle swings from side to side to make zigzag and other special stitches.

Electronic sewing machines are designed to make all kinds of stitches. The touch of a button or the insertion of a cartridge changes the motion of the needle so that it embroiders, makes buttonholes, monograms, or combines stitches. Electronic sewing machines have become increasingly computerized. For example, some machines can measure a button and then make as many buttonholes of the same size as are needed.

Most sewing-machine manufacturers make all the main types of machines. Electronic machines are the most expensive. Many of the sewing machines on which zigzag stitching can be done are manufactured in Europe. The Anker and the Pfaff machines come from Germany; the Necchi and the Borletti from Italy; and the Viking from Sweden.

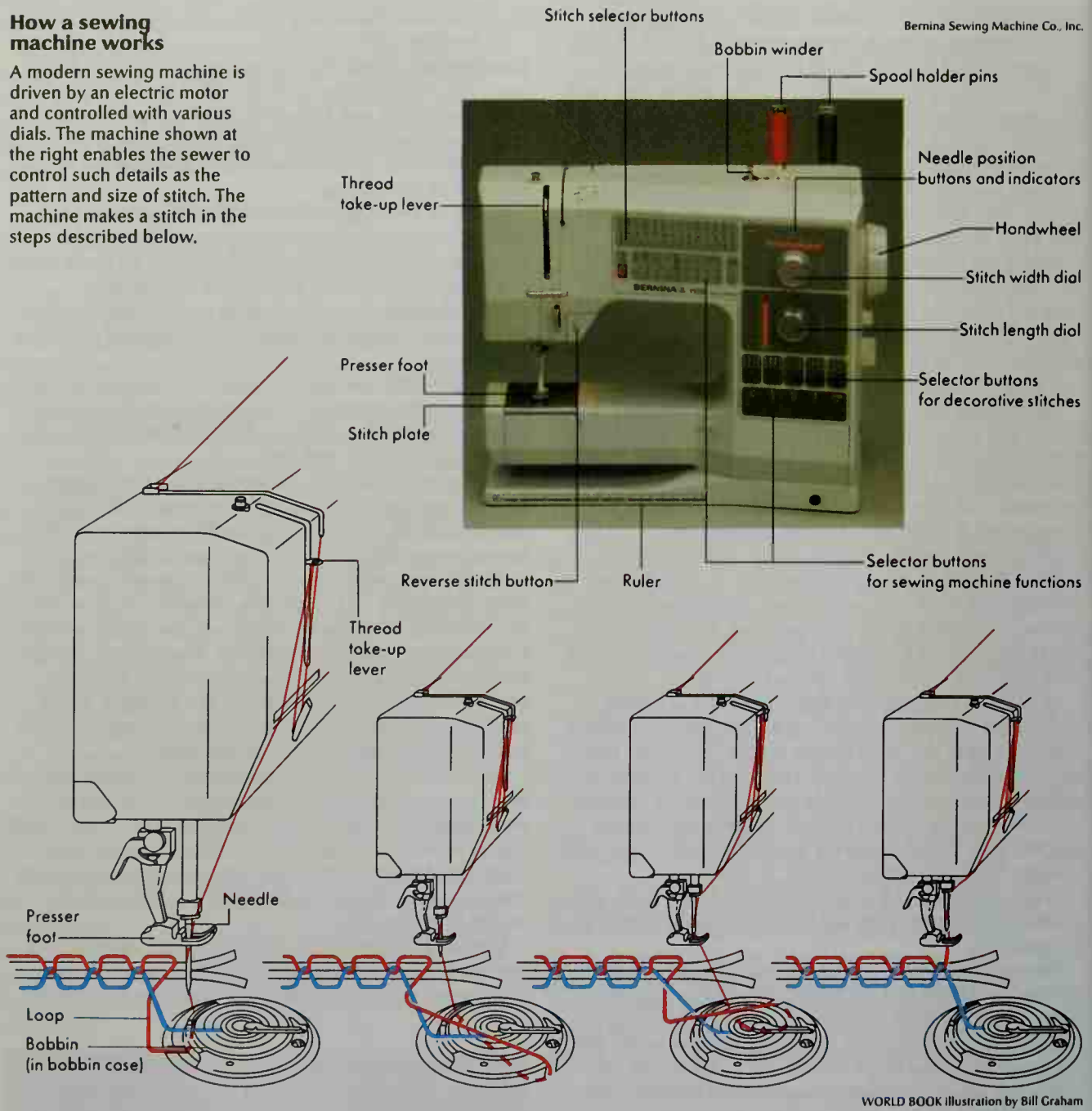
History. Thomas Saint, an Englishman, patented the first sewing machine in 1790. It made a single-thread chain stitch to stitch leather. It fed the thread automati-

Vogue Fabrics Sewing Center (WORLD BOOK photo by Steinkamp/Ballogg)

Sewing machine attachments have special features. The monogrammer on this machine makes letters of various sizes and designs.

How a sewing machine works

A modern sewing machine is driven by an electric motor and controlled with various dials. The machine shown at the right enables the sewer to control such details as the pattern and size of stitch. The machine makes a stitch in the steps described below.



1. A stitch is made with thread from the needle and the bobbin. First, the needle and its thread enter the cloth.

2. As the needle rises, its thread forms a loop. The loop goes around the bobbin and circles the bobbin thread.

3. The loop slips off the bobbin as the bobbin rotates. The needle rises and the stitch tightens around the cloth.

4. When the needle point is above the cloth, the fabric feed pulls more cloth forward and another stitch begins.

cally to a needle which had a notch instead of an eye. An awl made holes for the needle to pass through the leather. This machine was not practical.

In 1830, Barthélemy Thimonnier of France patented a machine for making soldiers' uniforms. His machine used a hooked needle that made a stitch by passing backward and forward through the cloth. The French government had as many as 80 of these machines in use at one time. Thimonnier was almost killed when angry workers wrecked his sewing machines because they put many people out of work. An American, Walter Hunt, invented a sewing machine in the 1830's, but never patented it.

Elias Howe is usually considered the inventor of the sewing machine as we know it today. His model, patented in 1846, was the first practical machine sold to users. Howe's machine had a needle with an eye near the point. A shuttle carried a thread below the cloth on a small bobbin. The needle, carrying an upper thread, was fastened to an arm that vibrated on a pivot. Movement of the arm forced the needle through the cloth. The shuttle carried the under thread through the loop of the upper thread, thus making a lock stitch. Nearly all sewing machines used in the home today are of this double-thread, lock-stitch type. Some people prefer the single-thread, chain-stitch machine, such as the Willcox and Gibbs. But the lock stitch is less likely to ravel than the chain stitch.

Of the inventors who came after Howe, A. B. Wilson and Isaac Singer deserve special mention. Wilson introduced the four-motion automatic feed used on nearly all present-day sewing machines. Wilson's automatic feed sewing machine was patented in 1854. In 1851, Singer had patented the foot-operated treadle and the presser foot with a yielding spring, which holds the fabric down on the feed plate.

Today, there are special machines for sewing boots and shoes, books, umbrellas, and brooms. There is even a machine for sewing carpets together. It travels along the carpet because the carpet is too heavy to be moved easily. The Singer Manufacturing Company (now The Singer Company) first put an electric motor on a sewing machine in 1889. Today the majority of sewing machines are electric, but some still have foot treadles.

Mary E. Conover

See also Howe, Elias; Singer, Isaac Merrit; Sewing.

Sex. See Sexuality.

Sex discrimination, sometimes called *gender discrimination,* is the unequal treatment of individuals based on their sex. Laws and traditions have helped cause such unequal treatment in most societies throughout history. Sex discrimination has limited the opportunities of both women and men, but especially those of women. Until the early 1900's, for example, nearly all countries denied women the same voting rights as men. In many countries, women still hold few or none of the most powerful jobs and political offices. This inequality exists even though women make up about half the population of nearly every country. People who oppose unequal treatment of the sexes often refer to such treatment as *sexism.*

Views on sex discrimination vary from culture to culture. Many people in Western societies view unequal treatment of the sexes as harmful and unjust. However, numerous people, especially in non-Western societies, believe it is natural and right that only women perform certain tasks and only men perform certain others. In some cultures, a large majority of women seem to accept their traditional sex roles. In some Middle Eastern and Asian countries, for example, tradition separates women of child-bearing age from the company of men except for members of their own family. But few women in these countries protest the traditional separation of the sexes.

Origins of sex discrimination. Sex discrimination probably was originally based on physical differences between men and women. Only women can bear children and nurse infants. As a result, women assumed most of the responsibility for child care. In addition, women are, on average, smaller and less powerfully muscled than men. These size and strength differences helped define certain physically demanding or dangerous jobs as "men's work." Physical and social barriers prevented women from entering many occupations. In Western societies, for example, most people expected women to remain at home raising children, preparing food, and cleaning. In addition, most people thought men should work outside the home to provide the family income. Some people still believe that the welfare of society depends on such a division of labor.

Changes in attitudes. Eventually, birth control gave women the means to limit or space their childbearing, and the development of machinery canceled out the advantage of male strength. Long-standing ideas about the proper roles of women and men began to change, especially in Western societies. Since the mid-1900's, many women have taken full-time jobs outside the home. In numerous families, this change has resulted in a redistribution of chores among family members. Many men now help with the cooking and cleaning. Some work as homemakers while their wives hold jobs outside the home. More women now perform such traditionally male chores as making household repairs. It has become more common to see women physicians, lawyers, police officers, and fire fighters—and male nurses and elementary-school teachers.

Persistence of sex discrimination. Despite changing ideas about men's and women's roles, unequal treatment persists. In numerous two-worker families, daily household chores are still not shared. Often, the husband expects his wife to cook, clean, and do most of the child rearing in addition to her full-time work outside the home.

Besides handling a heavy load of housework, many women who enter the work force find that, on average, they receive much less pay than men do. At first, many people blamed the difference in pay on women having less education or experience. But the large differences in pay have continued, even though women have gained more education and experience and entered professions traditionally dominated by men.

Society still discourages many girls from expecting professional success in such fields as mathematics, engineering, science, or architecture. Some researchers have reported that in a class of both boys and girls, teachers tend to give less attention to girls than to boys, especially in science and math classes.

In many professions, an individual's success depends in part on personal relationships with business or professional associates. In law, insurance, and other areas, however, many of these relationships have been formed in clubs that, until the late 1900's, excluded women. Without such relationships, individuals may lack the personal support and role models that help create a sense of personal and professional confidence.

Changes in laws. Many kinds of laws encourage or discourage unequal treatment of the sexes. They include laws that deal with divorce, employment, property, social security, and voting. Until the mid-1800's, for example, laws in the United States prohibited married women from making contracts, owning property, or controlling their own earnings. Until 1920, the laws of most U.S. states denied women the right to vote or gave them voting rights that were less extensive than those of men. In 1920, the 19th Amendment to the Constitution of the United States banned all laws that restrict women's voting rights.

Since 1960, the United States has adopted additional measures to reduce sex discrimination. For example, the federal Equal Pay Act of 1963 requires equal pay for men and women doing similar work. Title VII of the Civil Rights Act of 1964 prohibits job discrimination on the basis of a person's sex. Under this act, businesses cannot fire a woman for pregnancy if pregnancy does not affect her job performance, reserve specific jobs for only men or only women, or refuse to hire married women. Title

IX of the Education Amendments of 1972 bans sex discrimination by federally funded schools and colleges.

Also during the 1970's, the U.S. Supreme Court required that women wage earners receive the same benefits for their families that male wage earners do. Such benefits include social security, welfare, and workers' compensation. Many states have laws enabling a man to collect alimony if his former wife has a larger income than he does. Canada has sex-discrimination laws similar to those in the United States. Susan Lutz Wallace

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Education (Nonsexist education)
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Women's movements

Sex education is the study of human reproduction, sexual relationships, and the characteristics of being male or female. Such characteristics make up a person's *sexuality*. Sexuality is an important aspect of life, and almost everyone—including children—is curious about it.

Children can learn about sexuality from parents, physicians, church representatives, or other adults. They may also gather information from books and the media. Youths often receive incorrect information about sexuality from their friends. As a result, young people may form incorrect ideas long before a parent addresses the topic with them. Government agencies in many countries, including the Office of the Surgeon General in the United States, have called for more open communication with children and adolescents about sexuality. This article discusses how sex education is taught in schools and the controversy caused by such education.

How sex education is taught. Sex education programs vary greatly from school to school. Some schools limit classes to one or several years of junior high or high school. Others offer a complete program, which lasts from kindergarten through high school. In addition, some programs are *abstinence-only* programs, and others are *comprehensive programs*. Abstinence-only programs teach students to delay sexual relations until marriage. Comprehensive programs stress postponing sex, but also include information about birth control, sexually transmitted diseases, and other consequences and complications of sex. This section describes a typical complete sex education program.

From kindergarten through grade 4, sex education teaches children about their bodies and attempts to promote a wholesome attitude toward the self as a growing person. Children are taught that males differ from females, and that both sexes are needed to produce babies. During these years, teachers try to correct any false ideas about sexuality that the children may have learned.

In grades 5 and 6, teachers introduce information that helps prepare the students for puberty. For example, the children learn about menstruation, nocturnal emissions, and the changes that will take place in their bodies. They also study reproduction in human beings, and how the male and female sexual systems work.

Most students reach puberty in grades 7 through 9. Their interest in sexuality rises at this time. Sex education can teach these students about the responsibilities of intimate relationships and dating. They also may learn about birth control and sexually transmitted diseases.

High school students learn more about the social and psychological aspects of sexuality. Marriage and the family may be discussed, along with such topics as rape, abortion, homosexuality, pornography, and prostitution.

The dispute over sex education. Surveys show that most people favor some kind of sex education program in schools. Supporters of these programs feel that many parents have not done a complete job of teaching about sexuality. They also fear that children often receive false information from their friends and from magazines, motion pictures, and television. Therefore, they argue, school is the best place for children to receive correct, complete information about sexuality. Several studies have shown that sex education can promote responsible sexual behavior without increasing sexual activity.

Opponents of school-based programs argue that children should learn about sexuality only from their parents. They feel that children need moral guidance about sexuality, and that only parents can provide it. Some opponents of sex education charge that it causes young people to think about sex too much. Terri D. Fisher

See also **Calderone, Mary S.; Masters and Johnson; Sexuality; Sexually transmitted disease.**

Sex ratio is the proportion of males to females in a population. Studies of birth records for human beings and other animals indicate that many species have more individuals of one sex than of the other. Among human beings, for example, 103 to 107 boys are born for every 100 girls. But among adults, women outnumber men because women tend to live longer. Horses give birth to about 98 males for every 100 females. Chickens have about 95 males to every 100 females. Jeanne C. Biggar

Sextant is an optical instrument that measures the angular distance between any two points, such as the sun and the horizon. It is used for navigation and surveying. The instrument is named for its shape, which is roughly a sixth part of a circle. A sextant's frame supports a graduated arc, a movable *index arm* that represents the radius of the circle, two mirrors, and a small telescope. One of the mirrors—called the *horizon glass*—is fixed.

Kurt Scholz, Shostal

A navigator uses a sextant to measure the angle between a star and the horizon. Navigators must know this angle to find their position at sea by celestial navigation.

The second mirror—the *index glass*—is screwed to the index arm. The telescope sharpens the line of the horizon.

The sextant is held so that the graduated arc is vertical and the horizon shows in the horizon glass. The user looks through the telescope at the horizon glass and moves the index arm until the image of the sun or a certain star, reflected in the index glass, touches the horizon line. The altitude of the sun or star is read from the graduated arc. The user compares this altitude at various degrees of latitude to find the latitude of the ship.

The sextant works according to the optical rule: If an object is seen by repeated reflection from two mirrors that are perpendicular to the same plane, the angular distance between the object and its image is double the angle between the surfaces of the mirrors. The sextant's index measures the angle between the mirrors. This reading is doubled to give the angular distance of an object, such as the sun, above the horizon.

The mirror sextant was developed in the mid-1700's, based upon the work of John Hadley in England and Thomas Godfrey in America. The sextant was the primary navigation tool used on ships and aircraft until the mid-1900's. After World War II (1939-1945), such electronic aids as loran, omega, and radar began to replace the sextant (see **Navigation**). Robert L. Scheina

Sextillion, in Canada, France, and the United States, is a number followed by 21 zeros. One sextillion is written 1,000,000,000,000,000,000,000. In England and Germany, sextillion is a number followed by 36 zeros.

Sexton, Anne (1928-1974), was an American poet. She wrote about troubling, intimate experiences in a style intended to reveal raw feeling. Sexton dealt with such subjects as her mental illness, her sexuality, and her parents and children from a specifically female point of view. She began to write with the encouragement of her psychiatrist. Her poetry remains the vision of a disturbed suicidal individual, but it attempts to speak for modern experience as a whole. Her approach follows a trend set by the confessional poets Sylvia Plath, John Berryman, and Sexton's former teacher Robert Lowell.

Wide World

Anne Sexton

Sexton's first book of poems, *To Bedlam and Part Way Back* (1960), describes her emotional difficulties, her first suicide attempt, and her first experience in a mental institution. She also uses these themes in *Live or Die* (1966), a book of poems that won the Pulitzer Prize in 1967.

Anne Harvey Sexton was born in Newton, Massachusetts. She briefly studied at the Garland School, a finishing school for women, before eloping in 1948. Sexton committed suicide in 1974. Her *Complete Poems* was published in 1981. Bonnie Costello

Sexton beetle. See **Burying beetle.**

Sexual harassment, in law, consists of deliberate and unwelcome sexual advances, unwanted requests for sexual favors, and certain other offensive conduct of a sexual nature. Sexual harassment may be committed by men or women in many different roles, such as that of boss, client, co-worker, fellow student, military superior, or teacher. But a large majority of cases involve the harassment of women by their male bosses or fellow employees. A number of countries, including the United States and Canada, have laws against sexual harassment.

Laws recognize two types of employment-related sexual harassment: (1) *quid pro quo* and (2) *hostile environment.* Quid pro quo harassment occurs when a person in authority requires sexual favors from an employee in exchange for a job advantage, such as getting hired or promoted or not getting fired. *Quid pro quo* is a Latin phrase meaning *one thing in return for another.*

In hostile environment harassment, the offender does not demand an exchange. Instead, a pattern of behavior makes the victim's job so unpleasant that the person's work is affected. The harassment may consist of asking sexual favors, making sexual comments, telling sexual jokes, or displaying pornographic pictures.

United States federal courts began to recognize a link between sexual harassment and job discrimination in 1976. In 1986, the Supreme Court of the United States ruled for the first time that sexual harassment is a form of sex discrimination forbidden by Title VII of the Civil Rights Act of 1964. Title IX of the federal Education Amendments of 1972 bans sex discrimination—and therefore sexual harassment—in any educational program funded by the federal government.

Canada's Supreme Court ruled in 1989 that sexual harassment is a form of sex discrimination. Federal and provincial laws prohibit sex discrimination throughout Canada. Susan Gluck Mezey

Sexuality is everything that distinguishes a person as either male or female. Human beings are born male or female, and the physical differences of the sexes play an important role in determining our sexuality. But sexuality also involves our inner sense of being a male or female, as well as ways of behaving.

Sexuality influences how we behave and feel in a wide range of situations. It affects how we view our roles in life, especially in family relationships, at school, in the workplace, and in our community. Our sexuality helps define our attitudes about love and sexual relationships. It partially determines who we are sexually attracted to and how we express ourselves sexually within a relationship.

Influences on sexuality

A wide variety of factors shape a person's sexuality. These factors can be broadly grouped as (1) biological, (2) psychological, and (3) cultural.

Biological factors are probably the most obvious influence on sexuality. The physical features of males differ from those of females. At birth, for example, a baby can be recognized as a boy or a girl by its *genitals* (sex organs). A boy has a fingershaped organ called a *penis* between his legs. Behind the penis is a small sack that holds two nearly round organs, the *testicles.* A girl has a narrow passage called the *vagina* between her legs. The vagina leads to female genitals—including the *uterus* and the *ovaries*—inside the body.

The bodies of boys and girls change noticeably during a period known as *puberty.* For most boys, puberty

starts between 12 and 14 years of age. For most girls, it begins a bit earlier. Both boys and girls grow taller and heavier during puberty. Hair grows under their arms and around their genitals.

Other changes during puberty add to the physical differences between males and females. As a girl goes through puberty, her breasts become larger and round out, and her hips become wider. Her genitals develop completely and begin to produce mature *eggs* (sex cells), making it possible for her to become pregnant. A girl also begins a normal monthly process called the *menstrual cycle*. During this cycle, the lining of the uterus thickens to prepare for pregnancy. If pregnancy does not occur, the uterus sheds its excess lining through the vagina. The resulting discharge of blood and tissue is called *menstruation*. See **Menstruation.**

As a boy goes through puberty, his shoulders broaden, he gets stronger, and his voice becomes deeper. Hair grows on his face. His genitals begin to produce mature *sperm* (sex cells), making it possible for him to make a female pregnant.

Psychological factors that influence our sexuality include personal beliefs, emotions, and feelings. As young children, we develop a concept of ourselves as either male or female. We also learn how a person of our sex is expected to act in society. Parents, friends, teachers, television and other forms of mass communication, religious teachings, and many other sources help shape how we feel about our sexuality.

Sexual attitudes and behavior often involve intense emotions and attractions. Feelings of sexual desire may begin during the biological changes of puberty, but they are influenced by social learning. Both our conscious and unconscious thoughts influence how we respond sexually to another person.

Cultural factors. Every society has its own beliefs about the ways that males and females should behave. As a result, attitudes about sexuality vary widely from culture to culture. The people of one culture may regard legs, earlobes, and the back of the neck as sexually attractive. But people of another culture may find nothing at all sexual about these body parts. Similarly, such body decorations as tattoos or cosmetics might be considered appropriate in one culture but not in another.

Ideas about the roles of the sexes also vary widely from society to society. For example, in most of Italy, it is common for men to express affection for each other with big, emotional hugs. In the United States, a public display of affection between men is less common.

Sex and gender

Many people use the terms *sex* and *gender* interchangeably. However, social scientists consider the two terms to have different meanings. Sex refers to the physical characteristics that make a person male or female. The term is also used to describe the sexual activities that occur between individuals who are involved in an intimate relationship. Gender refers to a sense of being male or female or having the recognizable traits of one's sex. Characteristics and behavior generally associated with being a male are called *masculine*. Characteristics and behavior generally associated with being a female are called *feminine*.

The development of sexuality is influenced by two major forces related to gender: *gender identity* and *gender role*. Gender identity is a personal sense that "I am a male" or "I am a female." It develops partly from biological influences, such as body shape and genitals, and partly from cultural influences, including clothing and hairstyle. Gender role refers to a society's expectations for males and females, including values, attitudes, and behavior. Individuals develop these expectations with the influence of parents, friends, and teachers, as well as television, motion pictures, and other sources.

Gender identity

A person's sense of maleness or femaleness is set early in life, probably by the age of four. Research indicates that gender identity develops partly from the way a person is raised and partly from biological factors.

Before birth. A human being's sex is determined at *conception*, also called *fertilization*. Conception occurs when a sperm unites with an egg. This usually happens by means of sexual intercourse, but laboratory procedures can also achieve fertilization without intercourse. The fertilized egg develops and grows into what becomes a baby. Both the egg and the sperm each contain 23 *chromosomes* (threadlike strands that carry genetic information), including one *sex chromosome*. The sex chromosome carried by the egg is called an X chromosome. The sperm contains either an X or a Y chromosome. If an X-bearing sperm fertilizes the egg, the sex chromosomes form an XX pair, which results in a female baby. If the egg is fertilized by a Y-bearing sperm, the sex chromosomes form an XY pair, resulting in a male baby.

In childhood, gender identity is influenced greatly by one's parents. Traditionally, parents raised boys much differently than girls. They often encouraged boys to hold back emotions and to be independent, self-reliant, and competitive. Girls were expected to have the opposite characteristics. Adults encouraged children to play with toys that helped prepare them for traditional male or female roles. For example, girls commonly received tea sets and dolls as gifts, while boys received trucks, toy guns, and footballs. Some parents gave their children home chores that reinforced their gender identity. Girls worked in the kitchen and helped with laundry, while boys did outdoor or mechanical jobs.

These gender distinctions are still practiced to some extent. However, increasing numbers of parents try to raise their children with the best characteristics of both genders. Both boys and girls are encouraged to be independent and self-reliant. Girls do mechanical jobs, and boys help care for other children. Nevertheless, most parents still treat boys and girls differently. For example, parents may dress boys and girls differently and decorate their rooms in contrasting ways, choosing plainer styles for boys and frillier ones for girls.

Special cases of gender identity. A small number of males and females believe they should have been born a member of the other sex. Such individuals, called *transsexuals,* believe they have the wrong body for the feelings and emotions that they experience in their lives. They may feel they are "trapped" in the body of the wrong sex. Some transsexuals have surgery to change their anatomy to match their feelings. Estimates of the number of transsexuals in the United States range

from 10,000 to 25,000. The cause of transsexualism is unknown. See Transsexualism.

Transsexualism differs from *transvestism*. A transvestite enjoys dressing in the clothes of the other sex. But transvestites have the gender identity of their biological sex. Most transvestites are males who prefer sexual relationships with women, but who find it satisfying to dress in women's clothing.

Gender roles

Each of us develops general beliefs about males and females, including assumptions about appropriate attitudes and behavior for each gender. Our concepts of masculine and feminine gender roles profoundly affect our sexuality and our relationships.

The terms *masculinity* and *femininity* usually refer to a combination of physical traits, such as body shape, voice, and facial hair, and acquired characteristics such as hairstyle, clothing, body movements, and display of emotions. When we meet people for the first time, most of us quickly note the person's gender based on these traits and characteristics. We tend consciously or unconsciously to judge the masculinity or femininity of people by how closely they correspond to our expectations for each gender.

Gender role expectations are often formed by male or female *stereotypes*. A stereotype refers to oversimplified characteristics applied as a generalization to a group of people. A stereotype represents a form of prejudgment applied to all individuals of a certain age, gender, physical appearance, ethnic group, or occupation.

Cultural influences. All societies have cultural guidelines for each gender's proper role and personality. In the past, most societies in Europe and the Americas associated masculinity with being independent, aggressive, and competitive. Most Europeans and Americans also considered it masculine to serve as the family's main financial provider and to take initiative in contacts with women. Feminine characteristics included being warm, emotional, dependent, and noncompetitive. Feminine individuals were also expected to *nurture* (take care of or "mother") men and children.

Other cultures, however, had different ideas about what defines masculinity or femininity. The American anthropologist Margaret Mead found such differences in her studies of the peoples of New Guinea during the 1920's and 1930's. Mead noted that among the Mundugumor, both sexes are gentle, nurturing, and nonaggressive. These behaviors would have been regarded as feminine in American society at that time. Among the Tchambuli, Mead observed a reversal of traditional American gender roles. Tchambuli men were quiet, understanding, and emotionally dependent. Tchambuli women were lively, businesslike, and independent.

In all societies, individuals learn rules governing gender roles from a variety of sources, including their family and church. Three other important sources are (1) peer groups, (2) school, and (3) the mass media.

Peer groups are people of the same age, background, occupation, or social status. Most people interact socially and become friends with people who are in their peer group.

Peer influence on gender roles begins at an early age. Even 3-year-olds have ideas about "what boys do" and "what girls do" and put pressure on one another to act according to those ideas. When children engage in behavior stereotyped as typical of the other sex, their peers may criticize them. For example, a boy who wears a frilly, pink shirt or a ponytail may be ridiculed by classmates. In addition, many children tend to select playmates of the same sex, which reinforces traditional gender roles.

During adolescence, the approval and acceptance of peers can be more important than the approval of parents. In high school, peer groups have sharply defined gender roles with rules about proper behavior for males and females. Individuals who do not meet the group's expectations for behavior may be subjected to ridicule, teasing, being left out of group activities, or other forms of pressure.

Schools teach far more about gender roles than is apparent in the formal curriculum. A teacher's values, attitudes, and behavior all influence those of students. A teacher who holds stereotyped gender role expectations may give boys more encouragement than girls without realizing it. For example, the teacher may praise boys for the intellectual content of their work, while girls may be praised for neatness. In the 1980's and 1990's, many schools began to provide training to help teachers ensure equal treatment for boys and girls.

The mass media include the various forms of mass communication—television, newspapers, magazines, radio, and motion pictures. Television plays a particularly large role in shaping a person's values, attitudes, and behavior. Many children spend long hours watching television.

Evidence indicates that people—especially young people—pattern their behavior after what they see or hear in the mass media. A style of clothing or hairstyle that becomes trendy on television or in motion pictures quickly becomes trendy at school.

Until the 1980's, television traditionally portrayed mostly stereotypical gender roles. Characters who appeared in nontraditional gender roles were frequently portrayed as silly or ineffective. For example, a male character who took care of a baby or a female character who attempted to fix an automobile might fail miserably at these tasks. Such portrayals of nonstereotypical roles reinforced ideas about how a male or female was "supposed" to act.

Television has increasingly portrayed women and men in nonstereotypical roles. Many female characters now are shown as assertive and independent with nontraditional careers, such as surgeons, military officers, or police officers. In addition, many male characters are shown as caring, nurturing husbands and parents. This trend is considered highly significant because the media's images of men and women have a major impact on our views of gender roles.

Androgyny. Many people view masculinity and femininity as opposites—that is, if a certain trait is considered feminine, its opposite will be viewed as masculine. Yet many characteristics traditionally regarded as masculine and feminine are not opposites, they are just different. It is unusual for a person to have exclusively masculine or feminine characteristics. Most people have a combination of both types of traits. This combination

of masculine and feminine traits in one person is called *androgyny.* The term comes from the Greek words *andros,* which means *man,* and *gyne,* which means *woman.*

Research indicates that highly androgynous people adapt well to a wide range of situations. For example, they feel at ease being independent, forceful, warm, or nurturing, whatever the situation demands. Some studies suggest that androgynous men and women have fewer psychological problems than those who adopt the old, traditional gender roles.

Sexual orientation

A person's *sexual orientation* determines whether that person is sexually attracted to individuals of the opposite sex, to those of one's own sex, or to both sexes. People who are primarily attracted to the opposite sex are called *heterosexuals.* People who are primarily attracted to members of their own sex are called *homosexuals.* Individuals who feel attracted to people of both sexes are *bisexuals.* See **Homosexuality.**

Scientists estimate that 1 to 10 percent of American adults are homosexuals, and a smaller percentage consider themselves bisexual. Despite considerable research, the origins of sexual orientation are not completely understood.

Love and sex. The relationship between love and sex is complex. Love typically involves strong feelings. These feelings may exist without sexual desire or sexual expression. For example, people may love their parents, children, grandparents, friends, or even their pets. Likewise, sex may occur without feelings of love. Some couples, both married and unmarried, have sexual relations without being in love with each other. Nevertheless, the feelings of being in love with and sexually attracted to another person are frequently intertwined.

Expressing sexuality. Every individual develops distinctive sexual values, needs, interests, fantasies, and preferences, all of which define the person's *sexual identity.* Our sexual identity determines how we express ourselves sexually.

Forms of sexual expression vary from holding hands and hugging to more intimate sexual contact, such as kissing and sexual intercourse. Sexual expression also can have many different meanings. For example, sexual intercourse can express love and indicate the deep intimacy within a relationship. For some couples, having a baby may be the primary reason for sexual intercourse. Others may have sex mainly for pleasure. People also use sex to try to feel more secure in a relationship or to prove their worth to the other person.

American society holds conflicting attitudes about sexuality. On the one hand, people learn the importance of sexual attractiveness from such sources as family, peers, school, and the mass media. From the same sources, however, people often pick up underlying feelings of anxiety and guilt about actually expressing their sexuality. In addition, many individuals and religious groups consider certain sexual behavior, such as homosexuality and sex outside marriage, to be morally wrong.

Each person must decide how she or he wants to express sexuality. Most people are influenced in their decision by values learned from their family, religion, or peer group.

Carol A. Cassell

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Adolescent
Brain (The work of the brain)
Homosexuality
Impotence
Kinsey, Alfred C.
Marriage
Masters and Johnson
Prostitution
Reproduction, Human
Sex education
Sexually transmitted disease

Additional resources

Basso, Michael J. *The Underground Guide to Teenage Sexuality.* 2nd ed. Fairview Pr., 1997.
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Sexually transmitted disease, also called STD, is any disease spread primarily through intimate sexual activity. Many bacteria, viruses, and other kinds of germs cause STD's. Sexually transmitted diseases were once commonly called *venereal diseases (vuh NIHR ee uhl).*

STD's are a major health problem throughout the world. The most commonly transmitted STD in the United States, chlamydia *(klah MIHD ee uh),* infects at least 4 million Americans each year. Chlamydia can cause a pelvic inflammatory disease in women who are infected, which can lead to infertility. HIV is another sexually transmitted infection. HIV is the virus that causes AIDS, a deadly disease. Other widespread STD's include gonorrhea, genital herpes, and syphilis.

How STD's are transmitted. STD's are transmitted almost entirely through direct person-to-person sexual intercourse with an infected person. Most germs that cause STD's die quickly outside the human body. For this reason, STD's are not transmitted through contaminated objects, such as eating utensils, towels, and toilet seats; or through casual contact, such as coughing, sneezing, or swimming in the same swimming pool.

Most of the common STD's can be transmitted from an infected pregnant woman to her baby. Transmission may occur as the fetus develops within the uterus or during childbirth, which can cause complications for both the woman and the baby.

Factors in the spread of STD's. An individual's chances of becoming infected with an STD depend on a variety of factors. STD's can affect people from all social and economic backgrounds. People with the greatest amount of risk are those who begin sexual activity at an early age, have many sex partners, or engage in sexual intercourse with high-risk individuals, such as prostitutes.

Cultural attitudes and values often affect the sexual behavior of individuals and thus influence their chance of STD infection. In the United States, changes in social and sexual customs have occurred that have contributed to an increased risk of STD's. These changes are (1) a dramatic increase in premarital sexual intercourse, (2) a decrease in the average age at which people first have intercourse, and (3) increased acceptance of having more than one sex partner. All these changes have contributed to an increase in the number of sexually active people in danger of becoming infected with an STD. In

the 1980's and 1990's, sexual behavior in many groups, such as homosexuals, changed dramatically because of the AIDS epidemic.

Within any society, there are individuals whose sexual behavior makes them highly likely to be infected with an STD and to transmit it to others. STD-infected people also tend to delay seeking treatment for their illness. They do not consult a doctor immediately because they either do not have or recognize the symptoms. Some do not see a doctor because they do not have access to good medical care. Poverty and a lack of educational and economic opportunities are associated with high rates of sexually transmitted diseases.

Biological factors also can affect a person's risk of STD infection. Individuals with genital ulcers may be more vulnerable than others to infection with HIV, the virus that causes AIDS. In addition, some STD-causing organisms become resistant to the drugs used for treatment, complicating efforts to control the spread of the STD. For example, some forms of the bacterium that causes gonorrhea have become resistant to penicillin and other antibiotics that are commonly used to treat this infection (see Gonorrhea).

Diagnosis and treatment. The most important factor after the diagnosis of an STD is obtaining appropriate medical care. For a person who shows few or no symptoms, doctors will often perform an STD test if the person reported a risky behavior or a sexual encounter. If a person shows obvious symptoms, doctors may then do a variety of laboratory tests to confirm the presence of the infecting organisms.

Doctors prescribe antibiotics to treat a variety of STD's. Such STD's, which include chlamydia, gonorrhea, and syphilis, can be cured easily if the drugs are prescribed early in the course of the illness. However, failure to receive prompt medical treatment can lead to serious, even life-threatening, complications. For example, syphilis that remains untreated can lead to heart or brain damage.

Viral STD's, including herpes and HIV, are incurable. Patients may carry these infections for many years without developing symptoms. In addition, in herpes and certain other viral STD's, patients may experience symptoms that go away, only to recur months or years later. Doctors can prescribe drugs to prevent or delay the development or recurrence of symptoms, and to reduce the severity of symptoms when they appear.

Prevention and control. The most effective strategies to stay free of STD's are to abstain from sexual intercourse altogether, or to limit such contact to one uninfected partner who, in turn, has no other sexual partners. People can significantly reduce the chance of infection by using condoms or other protective measures during sex, by avoiding sex with prostitutes and other high-risk individuals, and by not using drugs.

Controlling the spread of chlamydia, syphilis, and other bacterial STD's requires early treatment of infected individuals and their sexual partners. Screening people for STD's, even when they do not show any symptoms, is very effective. Many hospitals and community health centers have special clinics for the treatment of sexually transmitted diseases. Treatment is usually accompanied by education to encourage changes in the patient's sexual behavior. Educational campaigns in schools and the community may help limit the spread of bacterial STD's. Controlling the spread of HIV and other viral STD's is more difficult because the diseases are incurable. People with sexually transmitted diseases—particularly viral STD's—often are unaware of their infection and may infect many others. Education is thus the best tool for controlling the spread of viral STD's.

Individuals who believe they may have a sexually transmitted disease should see a physician immediately. They should also stop all sexual activity until told by a physician that they are not at risk of infecting others.

Jonathan M. Zenilman

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Pelvic inflammatory disease
Syphilis

Additional resources

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Seychelles, *say SHEHL* or *say SHEHLZ,* is an African country that consists of about 90 islands in the Indian Ocean. The islands are scattered over 400,000 square miles (1,000,000 square kilometers). The islands of Seychelles lie about 1,000 miles (1,600 kilometers) east of the African mainland.

Seychelles has a total land area of 176 square miles (455 square kilometers) and a population of 79,000. The largest island, Mahé, covers 59 square miles (153 square kilometers). About 85 percent of the nation's people live on Mahé. Most of the rest live on the next largest islands, Praslin and La Digue. Many of the smaller islands are uninhabited. Victoria, on Mahé, is the nation's capital, chief port, and only major town. It has about 24,000 people. Seychelles was ruled by Britain from 1814 until 1976, when it became independent.

The country's basic unit of money is the rupee. For a picture of the nation's flag, see the article Flag (Flags of Africa).

Government. Seychelles is a republic. The people elect a president, who heads the government and appoints a Cabinet. A 33-member Legislative Assembly makes the country's laws. Voters elect 22 members of the Legislative Assembly, and 11 members are appointed by the president.

People. About 90 percent of the people of Seychelles have mixed African and European ancestry. The others are Chinese, Europeans of British or French origin, and people from India. About half of the nation's people live in towns.

About a third of Seychellois workers are employed by the government. Another 25 percent work in the construction or the tourist industries, and about 15 percent are farmers.

Most people speak Creole, which is a dialect of French. The country's official languages are Creole, English, and French. Most Seychellois are Roman Catholics. Almost all Seychellois children attend school from the ages of 6 to 15. Some then join the National Youth Service, which provides academic instruction. Students also

E. Streichan, Shostal

Victoria, on the island of Mahé, is the capital and chief port of Seychelles. The harbor was rebuilt in 1975 to accommodate oceangoing vessels up to 700 feet (210 meters) long. About a third of the Seychellois people live in Victoria, the nation's only town.

learn skills to help develop the nation, such as raising crops and fishing. The Polytechnic offers advanced vocational training. Most of the country's adults can read and write.

Many Seychellois men and women live together without being married, and about half the children are born to unmarried couples. In many cases, the woman provides clothing for herself and the children, and the man buys his own clothes and food for the family.

Land and climate. Seychelles consists of granite islands and coral islands. The granite islands have streams, mountains, and white, sandy beaches. The soil is fertile. But the land has many rocks, making farming difficult. The coral group is made up of *atolls* (ring-shaped coral islands) and low islands with reefs that rise a few feet above sea level. These islands cannot support much plant life, and many are uninhabited.

Cinnamon grows wild on much of Mahé, and coconut palms flourish on many of the islands. The *coco-de-mer,* a double coconut that weighs as much as 50 pounds (23 kilograms), grows only in Seychelles. The country has many unusual species of plants and birds, and giant tortoises also live there.

Seychelles has a hot, moist climate. Annual temperatures average from 75 °F (24 °C) to 86 °F (30 °C). The average annual rainfall ranges from 52 inches (132 centimeters) on some of the coral islands to 92 inches (234 centimeters) on Mahé.

Economy of Seychelles is based on tourism. The country's remote location and beautiful beaches attract many vacationers. The tourist trade increased the need for hotels and restaurants, which led to the development of a construction industry during the 1970's.

A shortage of suitable farmland limits agricultural production in Seychelles. Cinnamon, coconuts, and *copra* (dried coconut meat) are the chief products. A growing fishing industry contributes to the economy.

An airport operates on Mahé, and a ferry travels daily among the three largest islands. The country has a TV station, a radio station, and two daily newspapers.

History. Portuguese sailors discovered Seychelles in the early 1500's. The islands were uninhabited at the time, and for the next 250 years they served chiefly as a hiding place for pirates. In 1742, an expedition from île de France (now Mauritius) explored Mahé. France claimed the islands in 1756.

About 1770, a group of white planters and African slaves came from île de France and settled on Mahé. For many years, Seychelles served as a supply station for French ships sailing to India and the East Indies. During the 1790's, war broke out between France and several European nations, including Britain. A treaty signed in 1814 gave Seychelles to Britain. Conditions on the islands declined under British rule. Britain did not establish schools there until 1944. During the early 1970's, many Seychellois began to demand an end to British rule. Seychelles became independent in June 1976. Since 1977, President France Albert René has been the country's most powerful leader. Until 1993, his Seychelles People's Progressive Front was the country's

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Seychelles

only legal political party. Opposition parties were allowed that year. Burton Benedict

Seymour, *SEE mohr,* **Horatio,** *huh RAY shee OH* (1810-1886), was a leading Democratic politician in New York from the 1840's to the 1860's. As governor of New York in 1863 and 1864, he became a leading *Copperhead*—that is, a Northern opponent of President Abraham Lincoln's administration during the Civil War. Seymour protested Lincoln's restriction of civil liberties during the war. He also opposed Lincoln's Emancipation Proclamation and the North's military draft. However, he was loyal to the North and raised troops for the war to fill New York's quota. Also, when a riot against the draft broke out in New York City in 1863, Seymour sent in troops to stop it.

Seymour was born in Onondaga County, New York. He briefly practiced law in Utica, and he served as mayor of the city in 1842 and 1843. Seymour was governor of New York in 1853 and 1854 as well as in 1863 and 1864. In 1868, Seymour received the Democratic nomination for the presidency. He lost the election to Ulysses S. Grant. Michael Perman

Seymour, Jane. See Henry VIII.

's Gravenhage. See Hague, The.

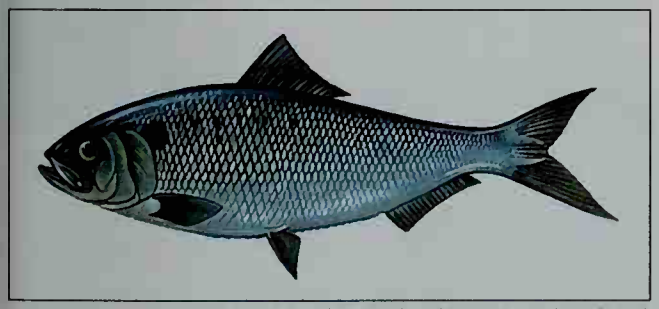
Shabuot. See Shavuot.

Shackleton, Sir Ernest Henry (1874-1922), an Irish explorer, led a British expedition from the Ross Sea that came within 97 nautical miles (180 kilometers) of the south geographic pole in 1908 (see **Antarctica** [The "Heroic Era"]). In 1914, he led an expedition into the Weddell Sea, where ice crushed his ship, the *Endurance.* His party escaped in boats to Elephant Island. Shackleton and four companions then made a daring journey by boat to South Georgia Island and crossed the island's glacier-covered mountainous ridge to summon rescuers. As a result, his entire party was saved. Shackleton was born in County Kildare. He wrote *Heart of the Antarctic* (1909) and *South* (1919). William Barr

Shad is an important food fish of the herring family. The American shad lives in the sea from Newfoundland to Florida. The United States Bureau of Fisheries, a forerunner of the U.S. Fish and Wildlife Service, introduced the fish into the Pacific Ocean.

The shad goes up freshwater rivers to spawn. At that time, large numbers of shad are caught in nets. Shad average about 3 pounds (1.4 kilograms) and are about 2 feet (61 centimeters) long. They are bluish above and have silvery sides.

Shad fisheries, which operate only at spawning time, have been greatly overworked, especially those of the East Coast rivers. So-called "Potomac shad" is shipped from the Pacific Coast to eastern markets. Most shad are eaten fresh, but a few are smoked or salted. Their eggs provide the best substitute for the *roe* (eggs) of sturgeon used in making caviar. David W. Greenfield



WORLD BOOK illustration by Colin Newman, Linden Artists Ltd.

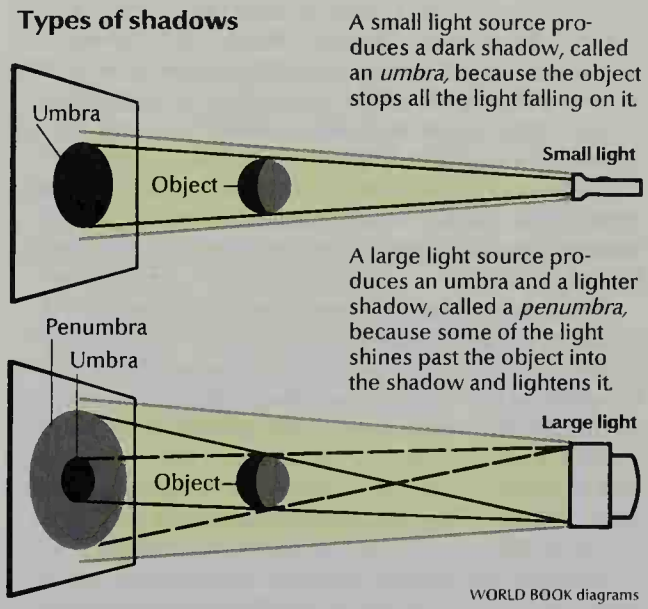
The shad is an important North American food fish. Shad are about 2 feet (61 centimeters) in length and have silvery sides.

Scientific classification. Shads belong to the herring family, Clupeidae. The American shad is *Alosa sapidissima.*

Shad fly. See Mayfly.

Shadow is the darkness that an object causes when it prevents light from shining on a surface. When you stand in sunlight, your body blocks some of the light that would otherwise have brightened the ground. Thus, your shadow is a dark area in the shape of your body. The earth casts a shadow in space, because it blocks some of the light from the sun. The moon darkens during a lunar eclipse when it moves into the earth's shadow.

A shadow falls from the side of an object opposite the light source. If the light source is smaller than the object, the shadow is evenly dark. A wide source of light creates a shadow with a dark center called the *umbra.* The umbra is surrounded by a lighter region called the *penumbra.* The umbra is dark because the object blocks all the light directed toward that part of the surface. The penumbra appears when some of the light gets past the object and reaches the surface.



In bright sunlight, objects have dark, crisp shadows. On cloudy or hazy days, shadows are fainter. On such days, the sunlight is dimmer and particles in the air scatter some of the light into the shadows, brightening them. Jearl Walker

See also **Eclipse; Penumbra; Sundial.**

Shadow matter is a hypothetical form of matter that is thought to interact with ordinary matter only through the force of gravity. If shadow matter exists, it is a form of *dark matter.* Dark matter is invisible matter that scientists believe makes up most of the mass of the universe. Dark matter is invisible because it does not give off, reflect, or absorb light. Unlike other hypothetical forms of dark matter, shadow matter cannot be detected in any laboratory experiment (see **Dark matter**).

Theoretical studies have shown that if shadow matter does exist, its properties are very different from those of ordinary matter. Therefore, such objects as stars and planets made of shadow matter could not form.

The possible existence of shadow matter has been proposed in *superstring theories*. Physicists believe that such theories may explain the nature of all particles in the universe and of the forces that control the behavior of the particles. Superstring theories suggest that subatomic particles, including particles that transmit forces, are actually extremely short, one-dimensional strings. Theoretically, the strings are so short that they appear to be points. Until recently, scientists had assumed that subatomic particles formed tiny points. Joel R. Primack

Shaffer, Peter (1926-), is an English playwright whose works range from comedies to dramatic portrayals of painful emotional crises. In many of his dramas, an unhappy and emotionally repressed character encounters a genius or saint. The character, aware of being ordinary, is driven to destroy the greater person when envy proves stronger than admiration.

The first of Shaffer's popular and artistic successes was *The Royal Hunt of the Sun* (1964). In this historical drama, the Spanish conqueror of Peru comes to believe in the mystical powers of the Inca king he must kill. In *Equus* (1973), a psychiatrist finds himself envying the inspired madness of a deeply troubled boy. *Amadeus* (1979) deals with the great Austrian composer Wolfgang Amadeus Mozart. The only person to truly appreciate Mozart's genius is his rival Antonio Salieri, who tries to ruin his career.

Shaffer's first stage play was *Five Finger Exercise* (1958), which portrays the effect of a tutor on a troubled family. *Lettice and Lovage* (1987) is a comedy about an imaginative tour guide's liberating effect on her employer. Shaffer also wrote the one-act comedies *The Private Ear* (1962), *The Public Eye* (1962), *Black Comedy* (1965), and *White Lies* (1967). His other plays include *The Battle of Shrivings* (1970), *Yonadab* (1985), and *The Gift of the Gorgon* (1993).

Shaffer's twin brother, Anthony Shaffer, also was a playwright and screenwriter. He became best known for the thriller *Sleuth* (1970). The brothers were born on May 15, 1926, in Liverpool. Gerald M. Berkowitz

Shagbark. See Hickory.

Shah was the title of the ruler of certain Middle Eastern countries, including Iran. See Iran (History); Mohammad Reza Pahlavi; Reza Shah Pahlavi; Shah Jahan.

Shah Jahan, *SHAH juh HAHN* (1592-1666), also spelled Shahjahan, ruled the Mughal empire in India from 1628 to 1666. During his reign, the Mughals reached their artistic Golden Age, with vast treasures and magnificent architecture. Shah Jahan is best remembered for the perfectly proportioned Taj Mahal, an immense tomb of white marble, which he built for his wife in Agra, India (see Taj Mahal). He also built the Great Mosque of Delhi and other large public structures. Many of these buildings still stand as examples of Mughal glory.

The Mughal dynasty began its decline because too much money was spent on luxuries and too much effort was wasted in war. Shah Jahan's reign added to these problems. One of his sons took his throne by force. Shah Jahan was born on June 5, 1592, in Lahore, India. Patricia Risso

Shahn, Ben (1898-1969), an American painter, tried through his art to communicate with people and influence their thinking and emotions. His realistic paintings and drawings deal directly and powerfully with such themes as labor movements, race relations, and atomic warfare.

Shahn was born on Sept. 12, 1898, in Lithuania and came to the United States when he was 8. He first attracted attention in the 1930's with a series of paintings about the Sacco-Vanzetti trial (see Sacco-Vanzetti case). Many of his paintings are murals. Shahn was a skilled draftsman and printmaker. He created both art prints and advertising illustrations. Shahn also expressed in his photography a compassionate interest in his fellow human beings. A series of his lectures on art was published as *The Shape of Content* (1957). Pamela A. Ivinski

Tempera painting on canvas (1931); collection of the Whitney Museum of American Art, New York City

Shahn's *The Passion of Sacco and Vanzetti* was one of a series of 23 pictures the artist painted to protest the execution in 1927 of two anarchists convicted of murder in Massachusetts.

Shaka, *SHAK uh* (1787?-1828), was a great Zulu leader who founded a powerful kingdom in southern Africa. He was born to Senzangakona, a Zulu chief, and Nandi,

a Langeni woman. At about age 22, he joined the army of Dingiswayo, king of the Mthethwa (pronounced *uhm TAY twah*) people. About 1816, his father died, and Shaka overthrew his elder half-brother Singukana to become leader of the Zulu. About 1818, Dingiswayo was murdered. Shaka then incorporated Dingiswayo's kingdom into the growing Zulu empire.

Shaka revolutionized warfare in southern Africa. He perfected a crescent-shaped battle formation, sometimes called *cow's horns,* which he used to encircle the enemy. He invented a short stabbing spear for close combat. His disciplined army conquered much of the present-day South African province of KwaZulu-Natal.

After his mother died in 1827, Shaka ordered strict mourning practices that led to violence in which thousands were killed. Many of his supporters then turned against him. In 1828, he was assassinated by two of his half-brothers and a servant. Charles O. Chikeka

See also **Zulu.**

Shaken baby syndrome is a pattern of severe injuries that can occur when an adult or older child violently shakes an infant. The injuries most often involved are bleeding into the brain and the *retina* (the light-sensitive tissue that lines the eyeball). The syndrome can kill babies or cause permanent brain damage.

Shaken baby syndrome is difficult for doctors to diagnose. A baby who has been violently shaken may seem less alert than usual. Shaken babies also may vomit or have seizures. Eye examination may show blood in the retinas. Imaging tests, such as computed tomography (CT) and magnetic resonance imaging (MRI), may reveal bleeding in the brain. Severely shaken babies may also have bruises, bumps, or other outward signs of head injury; damage to the neck or spinal cord; or broken bones, burns, or other signs of child abuse. Doctors suspect shaken baby syndrome when an examination fails to reveal any other likely cause of these symptoms. A caregiver who cannot or will not explain how the baby got hurt also raises suspicion.

Doctors are morally and legally obligated to report suspected cases of shaken baby syndrome to the police or to child welfare authorities. These authorities take steps to protect the baby from further abuse. Professionals seek to prevent child abuse by providing counseling and other support services to families, especially those having a high risk for abuse. Risk factors include physical or mental illness, substance abuse, high levels of stress, and isolation. Marianne Schuelein

See also **Child abuse.**

Shakers are members of a Christian sect officially named the United Society of Believers in Christ's Second Appearing. They acquired the name Shakers early in their history because they shook with religious zeal during worship services.

Shaker doctrine rested on refraining from sexual relations and confession of sin. Shakers believed that they should live separate from the outside world, and so they established their own communities where members shared their material goods. No one was born to the Shaker faith. All became members through adult conversion. But Shaker communities included children. Some children accompanied their convert parents; others were adopted by the Shakers or were placed in Shaker communities by parents or guardians unable to care for them. Upon coming of age, young people had the right to decide whether they wanted to remain.

The concept of separation from the world is central to Shaker theology. However, Shakers had extensive involvement with the outside world, trading with their neighbors and opening their religious services to the public. The Shakers became known for the high quality of their products and for their simple design, especially in furniture. See **Antique** (picture).

The Shakers first began to worship together in the 1740's around Manchester, England. In 1758, Ann Lee joined and became the leader. In 1774, she led eight of her followers to the American Colonies to escape religious persecution. At their peak, about 1830, American Shakers may have numbered 6,000 people, living primarily in New England, New York, Ohio, and Kentucky. Today, only about half a dozen Shakers remain, all in the Shaker community at Sabbathday Lake, Maine, near Auburn. Critically reviewed by the Shaker Museum and Library

See also **Kentucky** (Visitor's guide).

Shakers in New Lebanon, New York, a lithograph (about 1840) by Nathaniel Currier (Granger Collection)

Shakers at worship trembled and chanted wordless songs. A church leader said he saw the Hosts of Heaven worshiping in this manner, and he taught the movements to his people.

Stratford Festival Theatre, Ontario

Highly dramatic scenes add to the power of Shakespeare's great tragedies. In this scene from *Julius Caesar,* the young Roman leader Mark Antony delivers an eloquent funeral address over the body of the assassinated Roman ruler Julius Caesar. Antony begins his address to a crowd of common people with the famous line "Friends, Romans, countrymen, lend me your ears."

William Shakespeare

Shakespeare, William (1564-1616), was an English playwright and poet. He is generally considered the greatest dramatist the world has ever known and the finest poet who has written in the English language. Shakespeare has also been the world's most popular author. No other writer's plays have been produced so many times or read so widely in so many countries.

Many reasons can be given for Shakespeare's broad appeal. But his fame basically rests on his understanding of human nature. Shakespeare understood people as few other artists have. He could see in a specific dramatic situation the qualities that relate to all human beings. He could thus create characters that have meaning beyond the time and place of his plays. Yet his characters are not symbolic figures. They are remarkably individual human beings. They struggle just as people do in real life, sometimes successfully and sometimes with painful and tragic failure.

Shakespeare wrote at least 37 plays, which have traditionally been divided into comedies, histories, and tragedies. These plays contain vivid characters of all types and from many walks of life. Kings, pickpockets, drunkards, generals, hired killers, shepherds, and philosophers all mingle in Shakespeare's works.

In addition to his deep understanding of human nature, Shakespeare had knowledge in a wide variety of other subjects. These subjects include music, the law, the Bible, military science, the stage, art, politics, the sea, history, hunting, woodcraft, and sports. Yet as far as scholars know, Shakespeare had no professional experience in any field except the theater.

Shakespeare was born to what today would be called middle-class parents. His birthplace was the small market town of Stratford-upon-Avon. Shortly after he married at the age of 18, Shakespeare apparently left Stratford to seek his fortune in the theatrical world of London. Within a few years, he had become one of the city's leading actors and playwrights. By 1612, when he seems to have partially retired to Stratford, Shakespeare

Frank W. Wadsworth, the contributor of this article, is Professor of Literature Emeritus at the State University of New York, College at Purchase. He is the author of The Poacher from Stratford: A Partial Account of the Controversy over the Authorship of Shakespeare's Plays.

had become England's most popular playwright.

Shakespeare has had enormous influence on culture throughout the world. His works have helped shape the literature of all English-speaking countries and of such countries as Germany and Russia. Shakespeare also contributed greatly to the development of the English language. He freely experimented with grammar and vocabulary and so helped prevent literary English from becoming fixed and artificial.

Shakespeare's influence on language has not been limited to writers and scholars. Many words and phrases from Shakespeare's plays and poems have become part of our everyday speech. They are used by millions of people who are unaware that Shakespeare created them. For example, Shakespeare originated such familiar phrases as *fair play, a foregone conclusion, catch cold,* and *disgraceful conduct.* As far as scholars can tell, Shakespeare also invented such common words as *assassination, bump, eventful,* and *lonely.*

Many people can identify lines and passages as Shakespeare's even though they have never seen or read one of his plays. Examples include "To be, or not to be," "Friends, Romans, countrymen, lend me your ears," and "A horse! a horse! my kingdom for a horse!"

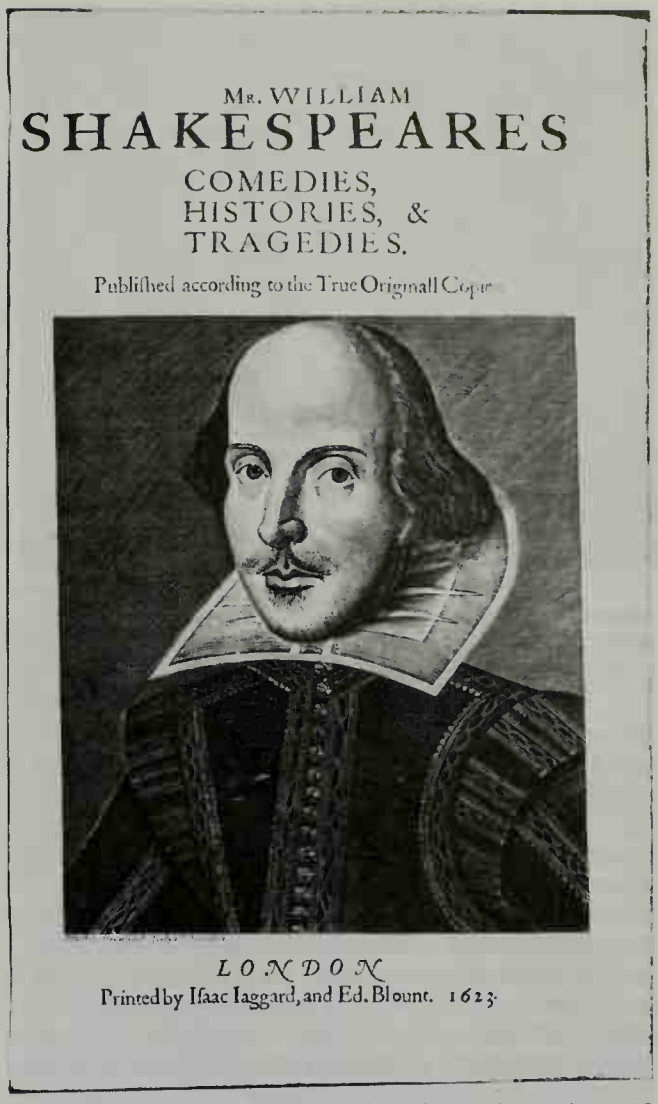
Shakespeare's genius as a poet enabled him to express an idea both briefly and colorfully. In his tragedy *Othello,* for example, he described jealousy as "the green-eyed monster which doth mock the meat it feeds on." In the tragedy *King Lear,* Shakespeare described a daughter's ingratitude toward her father as "sharper than a serpent's tooth."

Besides influencing language and literature, Shakespeare has affected other aspects of culture in the English-speaking world. His plays and poems have long been a required part of a liberal education. As a result, Shakespeare's ideas on such subjects as heroism, romantic love, and the nature of tragedy have helped shape the attitudes of millions of people. His brilliant portrayals of historical figures and events have also influenced our thinking. For example, many people visualize Julius Caesar, Mark Antony, and Cleopatra as Shakespeare portrayed them, not as they have been described in history books.

Even historians themselves have been influenced by Shakespeare's greatness. Shakespeare lived in England during the reign of Queen Elizabeth I, a period known as the *Elizabethan Age.* Historians consider the Elizabethan Age as a peak of English culture. But one can question whether the period would seem so important if Shakespeare had not lived and worked in it.

Shakespeare's widespread influence reflects his astonishing popularity. His plays have been a vital part of the theater in the Western world since they were written more than 300 years ago. Through the years, most serious actors and actresses have considered the major roles of Shakespeare to be the supreme test of their art.

Shakespeare's plays have attracted large audiences in big, sophisticated cities and in small, rural towns. His works have been performed on the frontiers of Australia and New Zealand. They were part of the cultural life of the American Colonies and provided entertainment in the mining camps of the Old West. Today, there are theaters in England, the United States, and Canada dedicated to staging some of Shakespeare's works yearly.



Engraving (1623); Folger Shakespeare Library, Washington, D.C.

A portrait of Shakespeare appears in the First Folio, the first edition of Shakespeare's collected plays. This portrait by the English artist Martin Droeshout is one of two images of the playwright considered authentic. The other is shown on page 349.

Shakespeare's plays appeal to readers as well as to theatergoers. His plays—and his poems—have been reprinted and translated countless times. Indeed, a publishing industry flourishes around Shakespeare, as critics and scholars examine every aspect of the man, his writings, and his influence. Each year, hundred of books and articles appear on Shakespearean subjects. Thousands of scholars from all over the world gather in dozens of meetings annually to discuss topics related to Shakespeare. Special libraries and library collections focus upon Shakespeare. Numerous motion pictures have been made of his plays. Composers have written operas, musical comedies, and instrumental works based on his stories and characters.

The world has admired and respected many great writers. But only Shakespeare has generated such varied and continuing interest—and such constant affection.

Neil Jinkerson, Jarrold Colour Publications

Shakespeare's birthplace was probably one of these two adjoining houses in Stratford. According to tradition, the playwright was born in the house on the left, called the *Birthplace*.

Peter Baker

A bedroom in the Birthplace is furnished in the style common among middle-class families of Shakespeare's day. Shakespeare may have been born in this room.

During the Elizabethan Age, the English cared little about keeping biographical information unrelated to affairs of the church or state. In addition, playwriting was not a highly regarded occupation, and so Elizabethans saw little point in recording the lives of mere dramatists. However, a number of records exist that deal with Shakespeare's life. They include church registers and accounts of business dealings. Although these records are few and incomplete by modern standards, they provide much information. By relating these records to various aspects of Elizabethan history and society, scholars have filled in the gaps in the factual account of Shakespeare's life. As a result, they provide a reasonably clear and dependable biography of the playwright.

His life in Stratford

Shakespeare's parents. John Shakespeare, William's father, was a glove maker who owned a shop in the town of Stratford-upon-Avon. Stratford lies about 75 miles (120 kilometers) northwest of London in the county of Warwickshire. John Shakespeare was a respected man in the town and held several important positions in the local government.

William Shakespeare's mother was born Mary Arden. She was the daughter of a farmer but related to a family of considerable social standing in the county. John Shakespeare married Mary Arden about 1557. The Ardens were Roman Catholics. Mary may also have been a Catholic, but the Shakespeares publicly belonged to the Church of England, the state church.

Early years. William Shakespeare was born in Stratford in 1564, the third of eight children. The register of Holy Trinity, the parish church in Stratford, records his baptism on April 26. According to the custom at that time, infants were baptized about three days after their birth. Therefore, the generally accepted date for Shakespeare's birth is April 23.

The Shakespeares were a family of considerable local prominence. In 1565, John Shakespeare became an alderman. Three years later, he was elected *bailiff* (mayor), the highest civic honor that a Stratford resident could receive. Later, he held several other civic posts. But toward the end of his life, John Shakespeare had financial problems.

Beginning at about the age of 7, young William Shakespeare probably attended the Stratford grammar school with other boys of his social class. The school's highly qualified teachers were graduates of Oxford University. Students spent about nine hours a day in school. They attended classes the year around, except for three brief holiday periods. The teachers enforced strict discipline and physically punished students who broke the

By permission of the Headmaster and Governors (Peter Baker)

The Stratford grammar school provided Shakespeare with all his formal education. He probably entered the school at about the age of 7. The school dates from 1417 and is still used.

rules. The students chiefly studied Latin, the language of ancient Rome. Knowledge of Latin was necessary for a career in medicine, law, or the church. In addition, Latin was considered a sign of an educated person. Young Shakespeare may have read such outstanding ancient Roman authors as Cicero, Ovid, Plautus, Seneca, Terence, and Virgil.

By modern standards, the Stratford grammar school must have been demanding, dull, and strict. And no evidence exists that Shakespeare had any teacher who might have stirred his imagination and brought routine studies alive.

In spite of the long hours he spent in school, Shakespeare's boyhood was probably not all boring study. As a market center, Stratford was a lively town. In addition, holidays provided popular pageants and shows, including plays about the legendary outlaw Robin Hood and his merry men. By 1569, traveling companies of professional actors were performing in Stratford. Stratford also held two large fairs each year, which attracted numerous visitors from other counties. For young Shakespeare, Stratford could thus have been an exciting place to live in.

Stratford also offered Shakespeare other pleasures. The fields and woods surrounding the town provided opportunities to hunt and trap small game. The River Avon, which ran through the town, had fish to catch. Shakespeare's poems and plays show a love of nature and rural life. This display undoubtedly reflects his childhood experiences and his love of the Stratford countryside.

Marriage. In November 1582, Shakespeare received a license to marry Anne Hathaway. She was probably the daughter of a farmer who lived in Shottery, a village about 1 mile (1.6 kilometers) from Stratford. At the time of their marriage, Shakespeare was 18 years old and Anne was 26. Their first child, Susanna, was baptized on May 26, 1583.

The lost years. Early in 1585, Anne Shakespeare gave birth to twins—a boy, Hamnet, and a girl, Judith. No significant factual information exists on Shakespeare's life for the period between Feb. 2, 1585, when the twins were baptized, and 1592, when evidence indicates Shakespeare was living in London. Scholars sometimes call this period *the lost years.*

Shakespeare's name appears with his parents' names in a Stratford lawsuit in 1588. But he may not have been living in Stratford at that time. Scholars believe that sometime during the lost years Shakespeare moved to London and served a period of apprenticeship in the city's busy theatrical life.

Early career in London

First recognition. There is some indication that Shakespeare had become well known in London theatrical life by 1592. That year, a pamphlet appeared with an apparent reference to Shakespeare. This reference suggested he had become both an actor and a playwright. A writer named Robert Greene had written a letter attacking theater owners, actors, and writers who, he believed, had abused the talents of university-educated playwrights, such as himself. After his death, the letter was published in a pamphlet called *Greene's Groatsworth* [a few cents' worth] *of Wit Bought with a Million of Repentance.* Most scholars agree that in one passage Greene attacked Shakespeare as an actor who thought he could write plays as well as educated dramatists could. This passage follows, with the Elizabethan spelling and punctuation modernized:

> . . . an upstart Crow, beautified with our feathers, that with his *Tiger's heart wrapped in a Player's hide,* supposes he is as well able to bombast out a blank verse as the best of you: and being an absolute *Johannes fac totum* [Johnny-do-everything], is in his own conceit the only Shake-scene in a country.

The line "Tiger's heart wrapped in a Player's hide" pokes fun at a line spoken by the Duke of York in Shakespeare's *Henry VI,* Part III. The line is "O tiger's heart wrapped in a woman's hide."

Following the publication of *Greene's Groatsworth of Wit,* Shakespeare must have complained about the attack to Henry Chettle, Greene's editor. Chettle then published an apology in which he appeared to praise Shakespeare as a polite and honest man as well as a fine writer. Part of Chettle's apology follows, with the spelling modernized:

> . . . I am as sorry as if the original fault had been my fault because myself have seen his demeanor no less civil than he excellent in the quality [acting occupation] he professes: Besides, divers of worship [various people of good reputation] have reported his uprightness of dealing, which argues his honesty, and his facetious [polished] grace in writing, that approves his Art.

His work in theater companies. Sometime after he arrived in London, Shakespeare probably joined one of the city's *repertory* theater companies. These companies consisted of a permanent cast of actors who presented a variety of plays week after week. The companies were commercial organizations that depended on admission prices for their income. They staged most of the plays Londoners attended.

Scholars do not know which theater company or companies Shakespeare joined before 1594. But he was a *sharer* (stockholder) of a company called the Lord Chamberlain's Men in 1594. The evidence consists of a record of payment to Shakespeare and his fellow actors for performances by the company at Queen Elizabeth's court. The Lord Chamberlain's Men was one of the most popular acting companies in London. Shakespeare was a leading member of the group for the rest of his career. By 1594, at least six of Shakespeare's plays had been produced.

His first poems. From mid-1592 to 1594, London authorities often closed the public theaters because of repeated outbreaks of plague. The need for new plays thus declined. At this time, Shakespeare began to write poems. The Elizabethans considered the writing of poetry much more important than the writing of plays. Shakespeare perhaps believed that by writing poems he might be able to win the praise that mere playwriting never received.

In 1593, Shakespeare's long poem *Venus and Adonis* was printed by Richard Field, a Stratford neighbor who had become a London printer. Shakespeare dedicated

the poem to 19-year-old Henry Wriothesley, the Earl of Southampton. The poet may have believed that the dedication would win him the earl's favor and support. *Venus and Adonis* quickly became a success.

Field printed Shakespeare's next long poem, *The Rape of Lucrece,* in 1594. Shakespeare also dedicated this poem to the Earl of Southampton. The wording of the dedication suggests the possibility that the young nobleman had rewarded the author, probably financially, for his dedication in *Venus and Adonis.*

Both poems went through many editions during Shakespeare's lifetime. But their success did not lead Shakespeare to give up playwriting. After the public theaters were reopened in 1594, he began again to write plays. Indeed, Shakespeare was one of the few Elizabethan writers who concentrated almost solely on the theater as a career.

The years of fame

From 1594 to 1608, Shakespeare was fully involved in the London theater world. In addition to his duties as a stockholder and actor in the Lord Chamberlain's Men, he wrote an average of almost two plays a year for his company. During much of this period, Shakespeare ranked as London's most popular playwright, based on the number of times his plays were performed and published. But his reputation was largely that of a popular playwright, not of a writer of unequaled genius. Few people gave him the praise that later generations heaped on him. An exception was the English clergyman and schoolmaster Francis Meres.

In 1598, Meres wrote *Palladis Tamia: Wit's Treasury,* a book that has become an important source of information about Shakespeare's career. In this book, Meres said of Shakespeare: "As *Plautus* and *Seneca* are accounted the best for Comedy and Tragedy among the Latins: so *Shakespeare* among the English is the most excellent in both kinds for the stage." Although Meres' praise did not represent everyone's opinion, it indicates that Shakespeare had become an established writer by at least the late 1590's. And he had not yet written most of his great tragedies, such as *Hamlet, Othello, King Lear,* and *Macbeth.*

By the late 1590's, Shakespeare had not only become an established writer, but he had also become prosperous. In 1597, he purchased New Place, one of the two largest houses in Stratford. Shakespeare obviously remained a Stratford man at heart in spite of his busy, successful life in London. Records of business dealings and of minor lawsuits reveal that he preferred to invest most of his money in Stratford rather than in London.

The Globe Theatre. In 1599, Shakespeare and six associates became owners of the Globe, a new outdoor theater in the London suburb of Southwark. The Globe was one of the largest theaters in the London area. It may have held as many as 3,000 spectators.

Also in 1599, a printer named William Jaggard published *The Passionate Pilgrim,* a book of 20 poems supposedly written by Shakespeare. However, the book contained only two of Shakespeare's sonnets and three poems from his comedy *Love's Labour's Lost.* The printer used Shakespeare's name on the title page to promote the book's sale, which illustrates the playwright's popularity at that time.

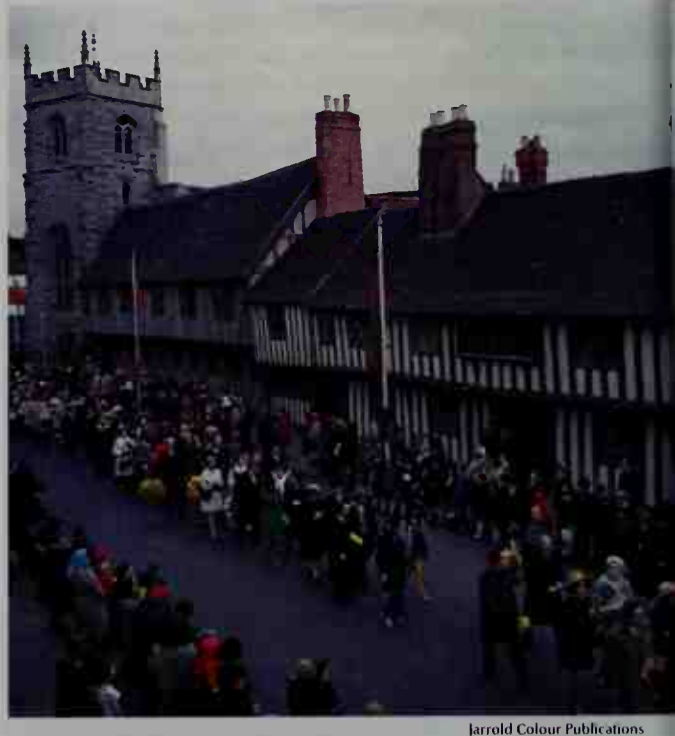
The King's Men. In 1603, Queen Elizabeth I died and was succeeded by her cousin James VI of Scotland. As king of England, he became James I. James enjoyed and actively supported the theater. He issued a royal license to Shakespeare and his fellow players, which allowed the company to call itself the King's Men. In return for the license, the actors entertained the king at court on a more or less regular basis.

James's support came at a convenient time. An outbreak of plague in 1603 had closed the theaters for long periods, making theatrical life uncertain. In fact, James's entry into London as king had to be postponed until 1604 because of the plague.

When James finally made his royal entry into London, the King's Men accompanied him. The members of the company were officially known as grooms of the chamber. In spite of this title and the name King's Men, the actors were not actually friends of the king. Their relationship to the royal court was simply that of professional entertainers.

The King's Men achieved unequaled success and became London's leading theatrical group. In 1608, the company leased the Blackfriars Theatre for 21 years. The theater stood in a heavily populated London district called Blackfriars. The Blackfriars Theatre had artificial lighting, was probably heated, and served as the company's winter playhouse. The King's Men performed at the Globe during the summer.

From 1599 to 1608 was a period of extraordinary literary activity for Shakespeare. During these years, he



Jarrold Colour Publications

A birthday celebration in Stratford honors Shakespeare each April 23, the traditional date of his birth. The celebration includes a procession that passes the Guild Chapel, with its stone tower, and the adjoining Stratford grammar school.

wrote several comedies and almost all the tragedies that have made him famous. Shakespeare's masterpieces during this period include the comedies *Much Ado About Nothing* and *Twelfth Night;* the history *Henry V;* and the tragedies *Antony and Cleopatra, Hamlet, Julius Caesar, King Lear, Macbeth,* and *Othello.*

The sonnets. In 1609, a London publisher named Thomas Thorpe published a book called *Shakespeare's Sonnets.* The volume contained more than 150 sonnets that Shakespeare had written over the years. Scholars have long been especially curious about the dedication Thorpe wrote to the book. The dedication reads, in modernized spelling: "To the only begetter of these ensuing sonnets Mr. W. H." Generations of researchers have failed to identify Mr. W. H. Scholars have also analyzed the sonnets to determine to what extent they are autobiographical. But their analyses have proved contradictory and generally unsatisfactory. Many critics suggest that readers simply enjoy the sonnets as some of the finest verse in English literature instead of examining the poems as autobiographical statements. For additional information on the sonnets, see the section *Shakespeare's poems.*

His last years

During his last eight years of life, Shakespeare wrote only four plays—*Cymbeline, Henry VIII, The Tempest,* and *The Winter's Tale.* In the past, some scholars argued that *The Tempest,* written about 1610, was Shakespeare's last play. They stated that he then retired almost completely to Stratford. However, *Henry VIII* can be dated about 1613. In addition, Shakespeare purchased a house in the Blackfriars district of London in 1613. The evidence thus suggests that Shakespeare gradually reduced his activity in London rather than ending it abruptly.

Shakespeare must have divided his time between his private life in Stratford and his public life in London. He had lodgings in London at least until 1604 and probably until 1611. Yet such family events as his daughter Susanna's marriage in 1607 and his mother's death in 1608 would certainly have called him back to Stratford. By 1612, he may have been spending much of his time in the comforts of New Place in Stratford.

On Feb. 10, 1616, Shakespeare's younger daughter, Judith, married Thomas Quiney, the son of his Stratford neighbor Richard Quiney. Six weeks later, Shakespeare revised his will. Within a month, he died. He was buried inside the Stratford parish church. His monument records the day of death as April 23, the generally accepted date of his birth

Shakespeare's son, Hamnet, died in 1596 at the age of 11. The playwright's daughter Susanna had one child, Elizabeth, who bore no children. Judith gave birth to three boys, but they died before she did. Shakespeare's last direct descendant, his granddaughter, Elizabeth, died in 1670.

The anti-Stratfordians

Through the years, the facts of Shakespeare's life have been confused with many tales based on hearsay and legend. During the 1800's in particular, admiration for

British Tourist Authority

A statue of Shakespeare stands in Stratford's Holy Trinity Church, where the playwright is buried. Scholars consider this statue and the engraving reproduced on page 345 to be the only authentic likenesses of Shakespeare.

Shakespeare grew so intense that it resulted in a totally uncritical attitude toward the man and his works. This attitude made Shakespeare almost into a god.

Some people so admired Shakespeare's plays that they refused to believe an actor from Stratford-upon-Avon could have written them. Shakespeare's commonplace country background did not fit their image of the genius who wrote the plays. These people, called *anti-Stratfordians,* proposed several other Elizabethan writers as the author of Shakespeare's works. The writers they suggest are sometimes called *claimants.* Almost all the claimants were members of the nobility or upper class. The anti-Stratfordians believed that only an educated, sophisticated man of high social standing could have written the plays.

Sir Francis Bacon was the first and, for many years, the most popular candidate proposed as the real author of Shakespeare's plays. Bacon's followers remain active today. But other anti-Stratfordians have had their own favorites. Edward de Vere, the 17th Earl of Oxford, is now more popular than Bacon. Other men to whom authorship has been credited include Roger Manners, the 5th Earl of Rutland; William Stanley, the 6th Earl of Derby; and Sir Walter Raleigh. Some anti-Stratfordians have also claimed that the writer Christopher Marlowe was the actual author. In spite of the claims made for these men, no important Shakespearean scholar doubts that Shakespeare wrote the plays and poems.

Collection of Simon Wingfield Digby, Sherborne, Dorset, England [American Heritage]

Queen Elizabeth I and her court lived in Shakespeare's London much of the time, adding color and excitement to the city's political and social life. This painting, completed about 1600 by an unknown artist, shows the queen and members of her court in a typical public appearance. Shakespeare's acting company performed many times before the queen and other nobles.

Shakespeare's works reflect the cultural, social, and political conditions of the Elizabethan Age. Knowledge of these conditions can provide greater understanding of Shakespeare's plays and poems. For example, most Elizabethans believed in ghosts, witches, and magicians. No biographical evidence exists that Shakespeare held such beliefs, but he used them effectively in his works. Ghosts play an important part in *Hamlet, Julius Caesar, Macbeth,* and *Richard III.* Witches are major characters in *Macbeth.* Prospero, the hero of *The Tempest,* is a magician.

Shakespeare's London had nearly 200,000 persons in 1600. By modern standards, it was a crowded, unsanitary city. The unsanitary conditions led to frequent epidemics of plague, in which thousands of people died. Most houses were overcrowded, and the inner rooms dark and musty.

The crowded streets helped give London an air of bustling activity. But other factors also made London an exciting city. It was the commercial and banking center of England and one of the world's chief trading centers. London was also the capital of England. The queen and her dazzling court thus lived in the city for much of each year, adding to the color and excitement. The city's importance attracted people from throughout England and from other countries. Artists, courtiers, teachers, musicians, students, and writers all flocked to London to seek advancement.

Although large for its day, London was still small enough so that a person could be close to its cultural and political life. The wide range of knowledge that Shakespeare showed in his plays has amazed many of his admirers. Yet much of this knowledge was the kind that could be absorbed by being in the company of informed persons. The range of Shakespeare's learning and the variety of his characters probably reflect his deep involvement in London life.

Elizabethan society. In the late 1500's, when Shakespeare began to write his plays, the English people tended to be optimistic. In 1588, the English navy won a great victory over the Armada, the huge Spanish fleet that tried to conquer England. The victory made England more secure and aroused strong feelings of patriotism. Following the triumph over the Armada, the English could agree with John of Gaunt in Shakespeare's *Richard II* that they were a "happy breed."

But the optimism of the late 1500's faded rapidly. By the time Queen Elizabeth died in 1603, the English were struggling with many social and economic problems. These problems were complicated by minor wars with

other countries—wars that often seemed without purpose. To many English people, the world appeared to be deteriorating and becoming, in Hamlet's words, "an unweeded garden / That grows to seed."

Shakespeare's plays reflect the shift from optimism to pessimism in Elizabethan society. All his early plays, even the histories and the tragedy *Romeo and Juliet,* have an exuberance that sets them apart from the later works. After 1600, Shakespeare's dramas show the confused, gloomy, and often bitter social attitudes of the time. During this period, he wrote his greatest tragedies. Even the comedies *Measure for Measure* and *All's Well That Ends Well* have a bitter quality not found in his earlier comedies. A character in the tragedy *King Lear* cries out in despair, "As flies to wanton boys are we to the gods. / They kill us for their sport." These lines reflect the uncertainties of the time, as well as the uncertainties of a particular dramatic situation.

Elizabethans were keenly aware of death and the brevity of life. They lived in constant fear of plague. When an epidemic struck, they saw victims carted off to common graves. Yet death and violence also fascinated many Elizabethans. Londoners flocked to public beheadings of traitors, whose heads were exhibited on poles. They also watched as criminals were hanged, and they saw the corpses dangle from the gallows for days. Crowds also flocked to such bloodthirsty sports as bear-baiting and bullbaiting, in which dogs attacked a bear or bull tied to a post.

Elizabethan literature mirrored the violence and death so characteristic of English life. Shakespeare's tragedies, like other Elizabethan tragedies, involve the murder or suicide of many of the leading characters.

In spite of their tolerance of cruelty, Elizabethans were extremely sensitive to beauty and grace. They loved many forms of literature, including poetic drama, narrative and lyric poetry, prose fiction, and essays. People of all classes enjoyed music, and English composers rivaled the finest composers in all Europe.

Instrumental music, singing, and dancing are important in Elizabethan drama. Some of Shakespeare's romantic comedies might almost be called "musical comedies." *Twelfth Night,* for example, includes instrumental serenades and rousing drinking songs as well as other songs ranging from sad to comic. Dances form part of the action in *The Tempest, The Winter's Tale,* and *Romeo and Juliet.*

The English ruler. Shakespeare's 10 history plays deal with English kings and nobility. Nine of the plays concern events from 1398 to the 1540's. A knowledge of these events and of the Elizabethans' attitude toward their own ruler can help a playgoer or reader understand Shakespeare's histories.

During the 100 years before Elizabeth I became queen, violent political and religious conflicts had weakened the throne. From 1455 to 1485, a series of particularly bitter civil wars tore England apart. The wars centered on the efforts of two rival noble families—the House of Lancaster and the House of York—to control the throne. The wars are called the Wars of the Roses because Lancaster's emblem was said to be a red rose and York's a white rose. Four of Shakespeare's historical plays deal with the Wars of the Roses. These plays, in historical order, are *Henry VI,* Parts I, II, and III; and *Richard III.*

During the early 1500's, England was divided by a religious struggle. In 1534, Henry VIII broke with the Roman Catholic Church. His action led to the formation of the Church of England. In 1553, Queen Mary I reestablished Catholicism as the state religion. But after Elizabeth I became queen in 1558, she reestablished the Church of England.

As a result of the preceding 100 years of conflict, Elizabethans came to believe that a strong but just ruler was absolutely necessary to keep social order. In seeing Shakespeare's history plays, they would have understood his treatment of royal responsibilities as well as royal privileges. Elizabethans would have been aware of the dangers of a weak king—dangers that Shakespeare described in *Richard II.* They would also have been alert to the dangers of a cruel and unjust ruler, which Shakespeare portrayed in *Richard III.*

Woodcut (1578) by an unknown artist; Folger Shakespeare Library, Washington, D.C.

A belief in witches was common in Shakespeare's time. The playwright used witches as major characters in his tragedy *Macbeth.* This woodcut shows Macbeth and his friend Banquo meeting three witches on a lonely road. The illustration appeared in the *Chronicles* by the English historian Raphael Holinshed. Shakespeare used Holinshed's book as a basic source for *Macbeth* and many other plays.

Shakespeare wrote his plays to suit the abilities of particular actors and the tastes of specific audiences. The physical structure of the theaters in which his works were presented also influenced his playwriting. He used many dramatic devices that were popular in the Elizabethan theater but are no longer widely used. Modern readers and theatergoers can enjoy Shakespeare's plays more fully if they know about the various theatrical influences that helped shape them.

Theater buildings. By the late 1500's, Elizabethan plays were being performed in two kinds of theater buildings—later called *public* and *private* theaters. Public theaters were larger than private ones and held at least 2,500 people. They were built around a courtyard that had no roof. Public theaters gave performances only during daylight hours because they had no artificial lights. Private theaters were smaller, roofed structures. They had candlelight for evening performances. Private theaters charged higher prices and were designed to attract upper-class patrons. Because Shakespeare wrote most of his plays for public theaters, this section deals chiefly with the design and structure of such buildings.

In 1576, James Burbage built England's first successful public theater, called simply The Theatre. It stood in a suburb north of London, outside the strict supervision of London government authorities. Soon other public theaters were built in the London suburbs. These theaters included the Curtain, the Rose, and the Swan. In 1599, Shakespeare and his associates built the Globe Theatre. Detailed evidence of how the Elizabethan public theaters looked is limited. But scholars have been able to reconstruct the general characteristics of a typical public theater.

The structure that enclosed the courtyard of a public theater was round, square, or many-sided. In most theaters it probably consisted of three levels of galleries and stood about 32 feet (10 meters) high. The courtyard, called the *pit,* measured about 55 feet (17 meters) in diameter. The stage occupied one end of the pit. For the price of admission, the poorer spectators, called *groundlings,* could stand in the pit and watch the show. For an extra fee, wealthier patrons could sit on benches in the galleries.

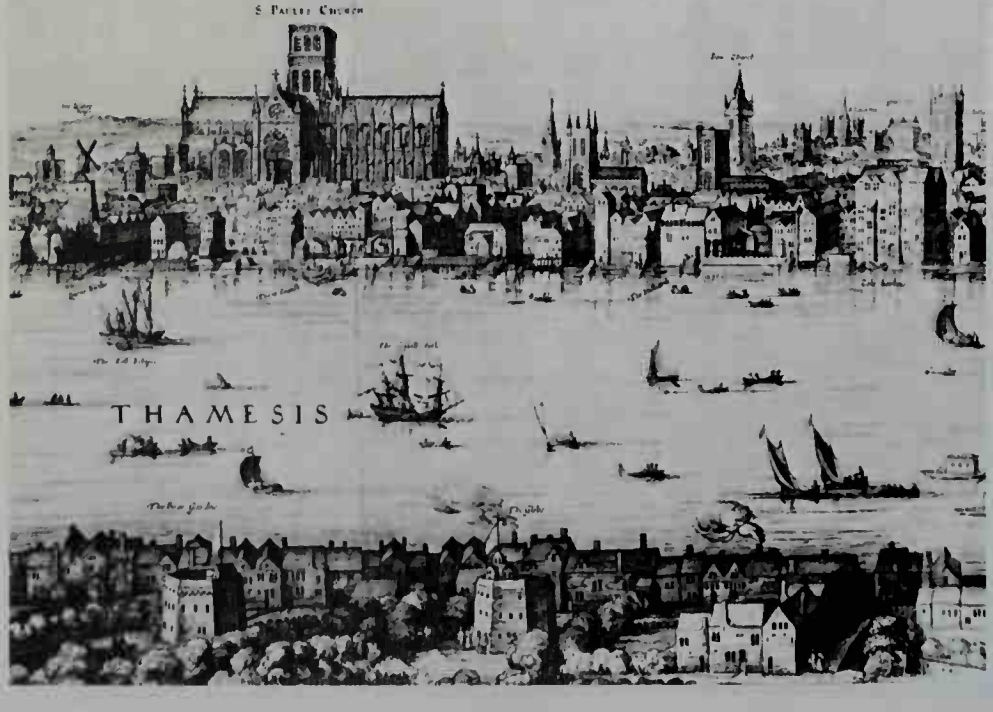
The stage of a public theater was a large platform that projected into the pit. This arrangement allowed the audience to watch from the front and sides. The performers, nearly surrounded by spectators, thus had close contact with most of their audience.

Actors entered and left the stage through two or more doorways at the back of the stage. Behind the doorways were *tiring* (dressing) rooms. At the rear of the stage, there was a curtained *discovery* space. Scholars disagree about the details of this feature. But the space could be used to "discover"—that is, reveal—one or two characters by opening the curtains. Characters could also hide there or eavesdrop on conversations among characters up front on the main stage. The gallery that hung over the back of the main stage served as an upper stage. It could be used as a balcony or the top of a castle wall. The upper stage allowed Elizabethan dramatists to give their plays vertical action in addition to the usual horizontal movement. Some theaters may have had a small third level room for musicians.

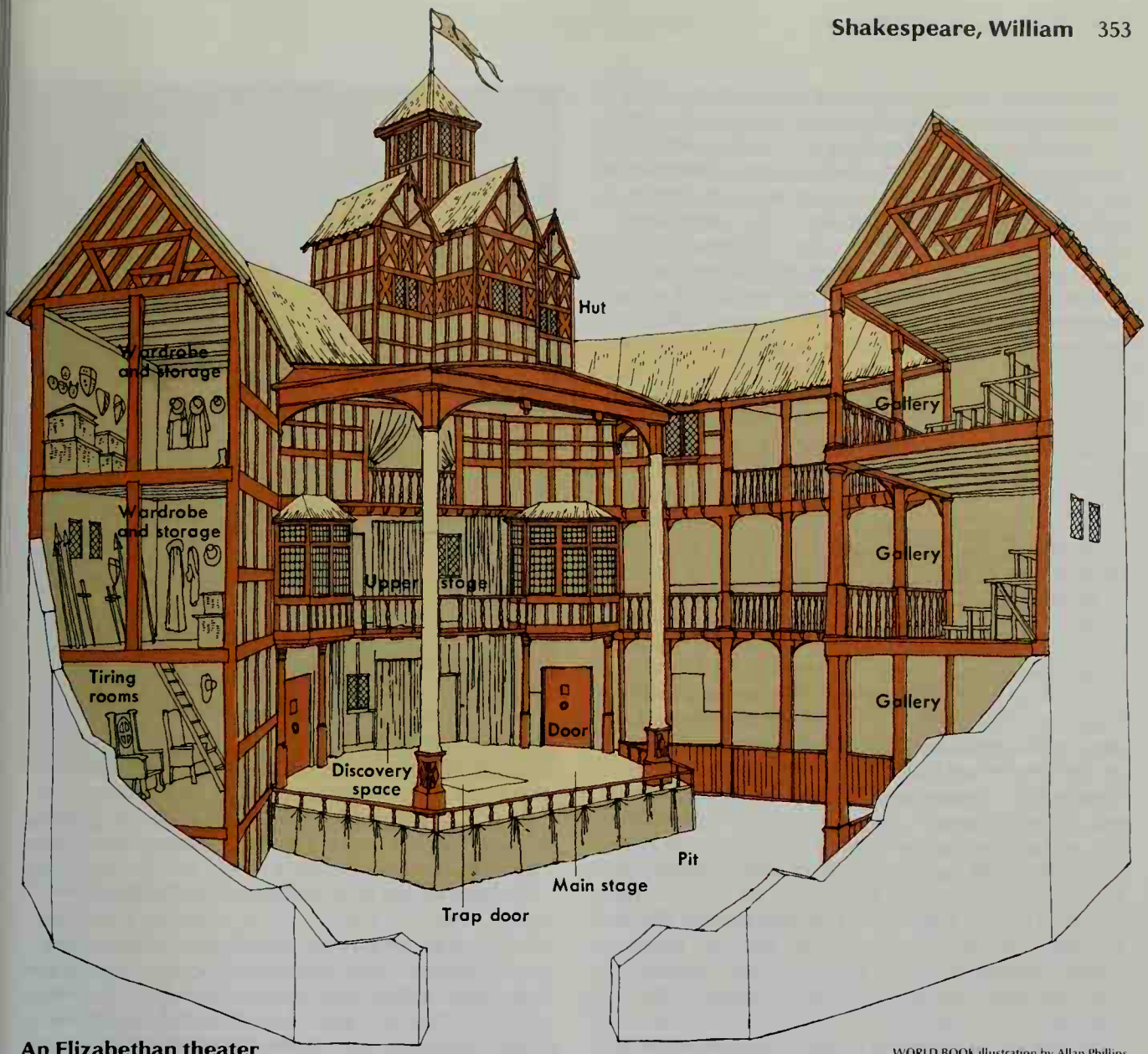
A half roof projected over the upper stage and the back part of the main stage. Atop the roof was a hut that contained machinery to produce sound effects and various special effects, such as the lowering of an actor playing a god. The underside of the hut was sometimes called the *heavens.* Two pillars supported the structure. The underside of the heavens was richly painted, and the interior of the theater undoubtedly had a number of other decorative features.

The main stage had a large trap door. Actors playing the parts of ghosts and spirits could rise and disappear

Detail of *Long View of London* (1616), an engraving by Claes Jansz Visscher; British Museum, London



The Globe Theatre became the home of Shakespeare's acting company in 1599. It stood near the south bank of the River Thames in the London suburb of Southwark. The Globe is the many-sided building in the lower center of this illustration. A similar structure to the left is the Hope Theatre, sometimes called the Bear Garden.



An Elizabethan theater

WORLD BOOK illustration by Allan Phillips

This illustration shows the general appearance of an Elizabethan public theater. The buildings were round, square, or many-sided. All were open at the top. Spectators stood in the pit or sat in the galleries. Actors performed on the main stage, in the discovery space, and on the upper stage. The hut atop the roof contained machinery to produce sound effects and various special effects.

through the door. The trap door, when opened, could also serve as a grave.

Scenic effects. Unlike most modern dramas, Elizabethan plays did not depend on scenery to indicate the *setting* (place) of the action. Generally, the setting was unknown to the audience until the characters identified it with a few lines of dialogue. In addition, the main stage had no curtain. One scene could follow another quickly because there was no curtain to close and open and no scenery to change. The lack of scenery also allowed the action to flow freely from place to place, as in modern motion pictures. The action of Shakespeare's *Antony and Cleopatra,* for example, shifts smoothly and easily back and forth between ancient Egypt and Rome.

Although the stage lacked scenery, various *props* were used, such as thrones, swords, banners, rocks, trees, tables, and beds. *Richard III* calls for two tents, one at each end of the stage.

Costumes and sound effects. The absence of scenery did not result in dull or drab productions. Acting companies spent much money on colorful costumes, largely to produce visual splendor. Flashing swords and swirling banners also added color and excitement.

Sound effects had an important part in Elizabethan drama. Trumpet blasts and drum rolls were common. Sometimes unusual sounds were created, such as "the noise of a sea-fight" called for in *Antony and Cleopatra.* Music also played a vital role. Shakespeare filled *Twelfth Night* with songs. In *Antony and Cleopatra,* the playwright included mysterious-sounding chords to set the mood before a fatal battle.

Acting companies consisted of only men and boys because women did not perform on the Elizabethan stage. A typical acting company had 8 to 12 sharers, a number of salaried workers, and apprentices. The sharers were the company's leading actors as well as its

stockholders. They had charge of the company's business activities. They bought plays and costumes, rented theaters, paid fees, and split the profits. The salaried workers, who were called *hirelings,* took minor roles in the plays, performed the music, served as prompters, and did various odd jobs. The apprentices were boys who played the roles of women and children.

The acting companies operated under the sponsorship either of a member of the royal family or of an important nobleman. Most sponsorships were in name only and did not include financial support. From 1594 to 1603, Shakespeare's company was sponsored, in turn, by the first and second Lord Hunsdon, a father and son. The first Lord Hunsdon held the important court position of lord chamberlain until he died in 1596. In 1597, his son became lord chamberlain. Thus from 1594 to 1603, Shakespeare's company was mostly known as the Lord Chamberlain's Men. After James I became king of England in 1603, he singled out the company for royal favor. It was then known as the King's Men.

Shakespeare was unusual among Elizabethan playwrights. He not only wrote exclusively for his own company but also served as an actor and sharer in it. The close association between Shakespeare, his fellow actors, and the conditions of production had enormous influence on his dramas. Shakespeare wrote most of his plays with a particular theater building in mind and for performers he had frequently acted with. Each major actor in the company specialized in a certain type of role. For example, one played the leading tragic characters, and another the main comic characters. Still another played old men. Shakespeare wrote his plays to suit the talents of specific performers. He knew when he created a Hamlet, Othello, or King Lear that the character would be interpreted by Richard Burbage, the company's leading tragic actor. Burbage's father, incidentally, had built England's first public playhouse, The Theatre.

Shakespeare's comedies reveal the influence that specific actors had on the creation of his plays. From 1594 to 1599, the company's leading comic actor was Will Kempe. During this time, Shakespeare's chief comic characters reflected the broad humor of Kempe, who was known for his vaudeville style of singing and dancing. Shakespeare wrote such lively comedies as *A Midsummer Night's Dream* and *Much Ado About Nothing* with Kempe in mind. After Kempe left the company, Robert Armin took his place, and the style of Shakespeare's comedy shifted noticeably. The playwright skillfully used Armin's more sophisticated and intellectual comic talents in such lively but thoughtful comedies as *Twelfth Night* and *As You Like It.*

Elizabethan acting companies required plays that had roles for all the major performers. Partly for this reason, comic scenes appear in even the most violent of Shakespeare's tragedies. Many of these scenes were included simply to give the company's leading comic actor a role. The first gravedigger in *Hamlet* and the porter in *Macbeth* are comic characters in Shakespeare's tragedies.

Scholars still debate the exact nature of Elizabethan acting style. Yet Elizabethan actors probably performed much as actors do today. However, they spoke their lines more rapidly than modern performers do. In addition, Elizabethan actors had an especially clear and musical speaking style. This method of speaking developed from years of acting experience and from the Elizabethan love for the musical possibilities of the English language.

Dramatic conventions. The writing and staging of Elizabethan plays were strongly influenced by various dramatic *conventions* (customs) of that time. The most widespread convention was the use of poetic dialogue. Although Shakespeare's plays contain prose and rhymed verse, he chiefly used an unrhymed, rhythmical form of poetry called *blank verse.*

Two common conventions that audiences expected were *soliloquies* and *asides.* In a soliloquy, an actor, who is alone on the stage, recites a speech directly to the audience. Or he speaks aloud to himself his thoughts and feelings. In an aside, a character speaks words that the other characters onstage are not supposed to hear. Audiences also liked and expected long lyrical speeches. Many of these speeches had little direct relation to the play's action. Mercutio's "Queen Mab" speech in *Romeo and Juliet* is a famous example.

The convention of boy apprentices playing women's roles contributed directly to some of Shakespeare's finest writing. The "boy actresses" were thoroughly trained and highly skilled. But Shakespeare had to rely on the magic of his verse rather than the loveliness of an actress to create feminine appeal. The "Beauty too rich for use, for earth too dear" of Juliet lay primarily in Shakespeare's language, not in the physical attractions of the performer.

Disguise played an important part in Elizabethan drama. Audiences enjoyed comic situations in which a boy played a girl character who disguised herself as a boy. Female characters masquerade as men in several of Shakespeare's plays, including *As You Like It, The Merchant of Venice,* and *Twelfth Night.* Social conditions also made disguise an effective theatrical device in Elizabethan times. The Elizabethans recognized sharp distinctions between social classes and between occupations. These distinctions were emphasized by striking differences in dress. Noblemen were immediately recognized by their clothing, as were doctors, lawyers, merchants, or pages. Characters could thus easily disguise themselves by wearing the garments of a certain social class or occupation.

Shakespeare's audiences. Shakespeare wrote most of his plays for audiences with a broad social background. To the Globe Theatre came a cross section of London society, ranging from apprentices playing hooky from work to members of the nobility passing the time. But most of the Globe's audience consisted of middle-class citizens, such as merchants and craftsmen and their wives. They went to the theater for the same reasons most people today go to the movies—to relax and to escape for a while from their cares.

Shakespeare's plays were also produced at the royal court, in the houses of noblemen, and sometimes in universities and law schools. For most of his career, he thus wrote plays that had to appeal to people of many backgrounds and tastes.

Paul Robeson as Othello; Billy Rose Theatre Collection, New York Public Library at Lincoln Center, Astor Lenox and Tilden Foundations

Othello was written during Shakespeare's third period, when he created his greatest tragedies. It concerns Othello, a black Moorish general, who marries a younger woman, Desdemona. Tricked into believing she has been unfaithful, Othello kills her.

Most scholars agree that there exist 37 plays by Shakespeare. A number of scholars have argued that Shakespeare also wrote all or part of certain other existing or lost plays. However, only one of these works, *The Two Noble Kinsmen,* has gained any acceptance. Many scholars believe that Shakespeare wrote the play with another English dramatist, John Fletcher. But most scholars omit this work from the accepted list of Shakespeare's dramas.

Much Shakespearean research has been devoted to determining the order in which Shakespeare's plays were written and first performed. The Elizabethans kept no records of premières of plays, and no newspapers existed to provide opening-night reviews. All Shakespeare's known plays were eventually published, but the publication date is not necessarily the date of a play's composition or première.

To establish the order in which Shakespeare's plays were probably written and first performed, scholars have relied on a variety of literary and historical evidence. This evidence includes records of performances, mention of Shakespeare's works by other Elizabethan writers, and references in Shakespeare's plays to events of the day. Scholars can also roughly date a play by Shakespeare's literary style. But for many of the plays, precise dates remain uncertain.

Traditionally, Shakespeare's plays have been divided into three groups—comedies, histories, and tragedies. At each stage of his career, Shakespeare tended to concentrate on a certain kind of drama, depending on the tastes of his audience at that time. For example, he wrote 9 of his 10 histories during a period when such plays were especially popular.

Shakespeare generally followed the Elizabethan custom of basing his plots on published historical and literary works. But he differed from most other dramatists in one important way. In retelling a story, Shakespeare shaped the borrowed material with such genius that he produced a work of art that was uniquely different from its source.

This section describes the plots and notable characteristics of all Shakespeare's plays. The plays have been divided into four periods, each of which reflects a general phase of Shakespeare's artistic development. Within each period, the plays are discussed in the order in which they were probably first performed.

For readers interested in a specific play or plays, the following table lists the plays alphabetically and gives the period in which a description of each play may be found.

Play	Period
All's Well That Ends Well	Third
Antony and Cleopatra	Third
As You Like It	Second
Comedy of Errors, The	First
Coriolanus	Third
Cymbeline	Fourth
Hamlet	Third
Henry IV, Parts I and II	Second
Henry V	Second
Henry VI, Parts I, II, and III	First
Henry VIII	Fourth
Julius Caesar	Second
King John	First
King Lear	Third
Love's Labour's Lost	Second
Macbeth	Third
Measure for Measure	Third
Merchant of Venice, The	Second
Merry Wives of Windsor, The	Second
Midsummer Night's Dream, A	Second
Much Ado About Nothing	Second
Othello	Third
Pericles	Third
Richard II	Second
Richard III	First
Romeo and Juliet	Second
Taming of the Shrew, The	First
Tempest, The	Fourth
Timon of Athens	Third
Titus Andronicus	First
Troilus and Cressida	Third
Twelfth Night	Second
Two Gentlemen of Verona, The	First
Winter's Tale, The	Fourth

The first period (1590-1594)

The plays of Shakespeare's first period have much in common, though they consist of comedies, histories,

and a tragedy. The plots of these plays tend to follow their sources more mechanically than do the plots of Shakespeare's later works. The plots also tend to consist of a series of loosely related episodes, rather than a closely integrated dramatic structure. In addition, the plays generally emphasize events more than the portrayal of character.

In his first period, Shakespeare's use of language indicates that he was still struggling to develop his own flexible poetic style. For example, Shakespeare's descriptive poetry in this period is apt to be flowery, rather than directly related to the development of the characters or the story.

The Comedy of Errors, a comedy partly based on *Amphitruo* and *Menaechmi,* two comedies by the ancient Roman playwright Plautus. Probably first performed during the period from 1590 to 1594. First published in 1623.

The action in *The Comedy of Errors* takes place in the ancient Greek city of Ephesus. The plot deals with identical twin brothers, both named Antipholus. Each brother has a servant named Dromio, who also happen to be twin brothers. The twins of each set were separated as children, and neither twin knows where his brother is living. One twin and his servant live in Ephesus. Their brothers live in Syracuse. After Antipholus and Dromio of Syracuse arrive in Ephesus, a series of mistaken identities and comical mix-ups develops before the twin brothers are reunited.

The Comedy of Errors has little character portrayal or fine poetry. However, the plot is filled with intrigue and broad humor, which make the play highly effective theater.

Henry VI, Parts I, II, and III, three related histories partly based on *The Union of the Two Noble and Illustrious Families of Lancaster and York* by the English historian Edward Hall and on the *Chronicles* by the English historian Raphael Holinshed. Each part probably first performed during the period from 1590 to 1592. Part I published in 1623, Part II in 1594, and Part III in 1595.

The three parts of *Henry VI* present a panoramic view of English history in the 1400's. The action begins with the death of King Henry V in 1422. It ends with the Battle of Tewkesbury in 1471. The plays vividly mirror the Wars of the Roses—the series of bloody conflicts between the houses of York and Lancaster for control of the English throne. Part I deals largely with wars between England and France. But all three plays dramatize the plots and counterplots that marked the struggle between the two royal houses.

The *Henry VI* plays are confusing to read because of their large and shifting casts of characters. The plays have much greater impact when performed than when read. On the stage, the constant action, exaggerated language, and flashes of brilliant characterization result in lively historical drama.

Richard III, a history partly based on *The Union of the Two Noble and Illustrious Families of Lancaster and York* by the English historian Edward Hall and on the *Chronicles* by the English historian Raphael Holinshed. Probably first performed in 1593. First published in 1597.

The play deals with the end of the Wars of the Roses. It opens with the hunchbacked Richard, Duke of Gloucester, confiding his villainous plans to the audience. He addresses the audience in a famous soliloquy that begins, "Now is the winter of our discontent/ Made glorious summer by this sun of York." Richard refers to the success of his brother Edward, Duke of York. Edward has overthrown Henry VI of the House of Lancaster and taken the English throne. Now weak and ill, he rules England as Edward IV. Richard wants to gain the crown for himself. He has his other brother, the Duke of Clarence, murdered. After King Edward dies, Richard sends the Prince of Wales, the dead king's older son, and the prince's brother to the Tower of London. After seizing the throne as Richard III, he has the two boys murdered.

Before long, Richard's allies turn against him and join forces with the Earl of Richmond, a member of the House of Lancaster. Richmond's forces defeat Richard's army at the Battle of Bosworth Field. Richard utters the famous cry "A horse! a horse! my kingdom for a horse!" as his mount is slain during the battle. Richmond finally kills Richard and takes the throne as King Henry VII.

The character of Richard is a superb theatrical portrait of total evil. But Richard blends his wickedness with such wit that his plotting becomes a delight to watch. On a deeper level, *Richard III* reminds audiences that when evil flourishes, society in general is to blame. People can be freed from the evil around them only when they themselves live up to the demands they make of their leaders.

The Taming of the Shrew, a comedy possibly based on *The Taming of a Shrew,* a comedy by an unknown English playwright, and on *Supposes,* a comedy by the English author George Gascoigne. Probably first performed in 1593. First published in 1623.

This play dramatizes how Petruchio, a young Italian gentleman, woos the beautiful but *shrewish* (bad tempered) Katherine, whose biting tongue has discouraged other suitors. Petruchio marries her. But before and after the wedding, he systematically humiliates Katherine to cure her of her temper. After many comical clashes between the two, Petruchio's strategy succeeds and Katherine becomes an obedient wife. At this point, Petruchio reveals himself to be a true gentleman and genuinely fond of Katherine.

A broad and vigorous comedy, *The Taming of the Shrew* provides two outstanding roles in the characters of the battling lovers. The parts of Petruchio and Katherine have been a showcase for generations of gifted actors and actresses.

Titus Andronicus, a tragedy possibly based in part on *The History of Titus Andronicus,* a story by an unknown English author. Probably first performed about 1594. First published in 1594.

This play is a type of melodrama that was popular in Elizabethan theater. The action takes place in and around ancient Rome. It involves a series of brutal acts of revenge by the Roman general Titus Andronicus against the men who raped his daughter, Lavinia. Shakespeare only occasionally lightened the play's bloody sensationalism with effective poetry and characterization. The evil plots of Aaron the Moor provide most

Holte Photographics

A Midsummer Night's Dream is a comedy that mixes realistic humor with scenes involving fairies and enchanted lovers. England's Royal Shakespeare Company gained acclaim for its imaginative interpretation of the play. This scene from the company's production shows fairies singing Titania, their queen, to sleep.

of the interest in an otherwise continuous parade of horror and violence.

The Two Gentlemen of Verona, a comedy partly based on *Diana,* a story by the Spanish author Jorge de Montemayor, and on *The Book of the Governor,* an educational work by the English author Sir Thomas Elyot. Probably first performed in 1594. First published in 1623.

The play is a witty comedy of love and friendship. It takes place in Italy. Two friends from Verona, Valentine and Proteus, meet in Milan. They soon become rivals for the love of Silvia, the daughter of the Duke of Milan. Valentine discovers Proteus as his friend is about to force his attentions on Silvia. Proteus repents his action, and Valentine forgives him. Valentine then tells his friend that he can have Silvia. But Valentine's generosity becomes unnecessary. Proteus learns that Julia, his former mistress, has followed him to Milan disguised as a page. Proteus realizes that he really loves Julia. He marries her at the end of the play, and Valentine marries Silvia.

In *The Two Gentlemen of Verona,* Shakespeare introduced several features and devices that he later used so effectively in the great romantic comedies of his second period. For example, he included beautiful songs, such as "Who Is Silvia?"; scenes in a peaceful, idealized forest; and a girl, disguised as a page, braving the dangers of the world.

King John, a history probably based in part on *The Troublesome Reign of John, King of England,* a play by an unknown English author. Probably first performed about 1594. First published in 1623.

The story concerns the efforts of England's King John to defend his throne against the claims of Arthur, the young Duke of Brittany. The powerful king of France supports Arthur. John has the allegiance of the brave and able Philip Faulconbridge and of the English nobility. But in time, John's evil and weak policies cost him the loyalty of his followers. Near the end of the play, both Arthur and John die violently. John's son then takes the throne as Henry III.

The most interesting character in *King John* is Faulconbridge. His sarcastic and witty comments on the personalities and motives of the other characters provide the play's best dialogue.

The second period (1595-1600)

During his second period, Shakespeare brought historical drama and Elizabethan romantic comedy to near perfection. Particularly in his histories and comedies of this period, Shakespeare demonstrated his genius for weaving various dramatic actions into a unified plot, rather than writing a series of loosely connected episodes. Throughout the second period, Shakespeare moved steadily toward the matchless gift for characterization that marks the great tragedies he produced in the early 1600's.

A Midsummer Night's Dream, a comedy probably based on several sources, none of which was a chief source. Probably first performed in 1595. First published in 1600.

The play begins in Athens, Greece, with preparations for a wedding between Theseus, Duke of Athens, and Hippolyta, queen of the Amazons. But most of the action takes place in an enchanted forest outside Athens. In the forest, two young men, Lysander and Demetrius, and two young women, Hermia and Helena, wander about together after they become lost. Lysander and Demetrius both love Hermia and ignore Helena, who loves Demetrius. Oberon, king of the fairies, orders the mischievous elf Puck to anoint Demetrius' eyes with magic drops that will make him love Helena. However, Puck mistakenly anoints Lysander's eyes, creating much comic confusion. Puck finally straightens out the mix-up.

In a subplot, Oberon quarrels with Titania, his queen. He then anoints Titania's eyes with the magic drops while she sleeps so that when she awakens, she will love the first living thing she sees. At this time, Nick Bottom, a weaver, and his comical friends are rehearsing a foolish play they plan to present at the duke's wedding. When Titania awakens, she sees Bottom and immediately falls in love with him. To increase Titania's humilia-

tion, Puck gives Bottom the head of a donkey. Aided by her fairy attendants, Titania woos Bottom until Oberon takes pity on her and has Puck remove the spell. The play ends with the duke's wedding. The two young couples—Lysander and Hermia and Demetrius and Helena—also marry during this ceremony. Bottom and his friends perform their hilariously silly play at the wedding celebration.

For *A Midsummer Night's Dream,* Shakespeare wrote some of his most richly descriptive poetry. Oberon tells Puck, "I know a bank where the wild thyme blows / Where oxlips and the nodding violet grows." The passage transports the audience in imagination to a magic wood where flowers bloom and fairies play. Shakespeare balanced this romantic fantasy with the rough humor of Bottom and his friends. The self-centered Bottom ranks as one of Shakespeare's finest comic figures. The comedy also has a serious side. Gaily but firmly, it makes fun of romantic love. As Puck comments, "Lord, what fools these mortals be!"

Richard II, a history partly based on the *Chronicles* by the English historian Raphael Holinshed. Probably first performed in 1595. First published in 1597.

As the play begins, King Richard exiles his cousin Bolingbroke from England. Later, Richard seizes Bolingbroke's property. While Richard fights rebels in Ireland, Bolingbroke returns to England and demands his property. After Richard learns of Bolingbroke's return, he hurries back to England to find his cousin leading a force of nobles who are discontented with Richard's rule. Instead of preparing the royal army to fight Bolingbroke, Richard wastes his time in outbursts of self-pity. He finally gives up his crown to Bolingbroke without a fight. Bolingbroke then orders that Richard be put in prison.

After Bolingbroke is crowned Henry IV, the imprisoned Richard is killed by a knight who mistakenly believed that the new king wanted Richard murdered. At the end of the play, Henry vows to make a journey to the Holy Land to pay for Richard's death.

In *Richard II,* Shakespeare seriously explored for the first time the idea that a person's character determines his fate. The play is a study of a weak, self-centered man. Richard becomes so out of touch with reality that his only defense of his kingdom is the hope that his "master, God omnipotent, / Is mustering in his clouds on our behalf / Armies of pestilence." When he faces the certain loss of his crown, Richard can only compare himself to Christ, who "in twelve, / Found truth in all but one; I, in twelve thousand none."

Love's Labour's Lost, a comedy probably based on several sources, none of which was a chief source. Probably first performed in 1596. First published in 1598.

King Ferdinand of Navarre and his friends Berowne, Longaville, and Dumain vow to live without the company of women for three years. But the princess of France unexpectedly arrives at the king's court with three female companions. The comedy centers on the efforts of the men to woo the women while pretending to keep their vow. At the play's end, the men propose to their visitors, who promise to give their answer in a year and a day.

This witty comedy has more references to events of the day than do any of Shakespeare's other plays. Many of these references have lost their meaning for modern audiences, which makes numerous passages difficult to understand. In addition, much of the language is elaborate and artificial. But Shakespeare included two simple and lovely songs—"When Daisies Pied and Violets Blue" and "When Icicles Hang by the Wall." *Love's Labour's Lost* also has handsome scenes of spectacle and several entertaining comic characters.

Romeo and Juliet, a tragedy based on *Romeus and Juliet,* a poem by the English author Arthur Brooke. Probably first performed in 1596. First published in 1597.

Romeo and Juliet deals with two teen-aged lovers in Verona, Italy, who are caught in a bitter feud between their families, the Montagues and the Capulets. Romeo, a Montague, and his friends crash a masked ball given by the Capulets. At the ball, Romeo meets Juliet, a Capulet, and they fall in love. The next day, the couple are secretly married by Friar Laurence. Returning from the wedding, Romeo meets Juliet's cousin Tybalt, who tries to pick a fight with him. But Romeo refuses to fight his new relative. To defend the Montague honor, Romeo's friend Mercutio accepts Tybalt's challenge. As Romeo attempts to part the young men, Tybalt stabs Mercutio to death. In revenge, Romeo then fights and kills Tybalt. As a result of the death of Tybalt, Romeo is exiled from Verona.

Juliet's father tries to force her to marry her cousin Paris, unaware that she is already married. To allow Juliet to escape from her father's demand, Friar Laurence gives Juliet a drug that puts her into a deathlike sleep for 42 hours. The friar sends a messenger to the exiled Romeo to tell him of the drug, but the messenger is delayed. Romeo hears that Juliet is dead and hurries to the tomb where she has been placed. There, he takes poison and dies by Juliet's side. Juliet awakens to find her husband dead and stabs herself. The discovery of the dead lovers convinces the two families that they must end their feud.

The popularity of *Romeo and Juliet* owes much to Shakespeare's sympathy for the young people in the play. Shakespeare seemed to blame the tragic ending on the blind self-interest of the adults. The success of the play also comes from effective characterizations and intensely lyrical poetry. Although frequently artificial, Shakespeare's language shows signs of the simpler, more direct style he would use in his later tragedies. For example, as Romeo watches Juliet on the balcony outside her bedroom, he sighs:

> See how she leans her cheek upon her hand!
> Oh, that I were a glove upon that hand,
> That I might touch that cheek!

The Merchant of Venice, a comedy partly based on a story in *Il Pecorone,* a collection of tales by the Italian author Giovanni Fiorentino. Probably first performed in 1597. First published in 1600.

Antonio, a merchant in Venice, Italy, borrows money from the Jewish moneylender Shylock and then lends the money to his friend Bassanio. Antonio has promised Shylock a pound of his flesh if he does not repay the

loan in three months. The three months pass, and Shylock demands his money. But Antonio cannot pay. Shylock then demands the pound of flesh.

Meanwhile, Bassanio has courted and married the beautiful and gifted heiress Portia. She has a plan to save Antonio from Shylock. Shylock goes to court to demand the flesh. Portia, disguised as a learned lawyer, asks him to reconsider in a famous speech that begins, "The quality of mercy is not strained." Shylock remains firm. Portia then warns him that he may take Antonio's flesh but not his blood. If Shylock spills any blood in taking the flesh, he will lose his property. Shylock drops his demand, and Antonio is saved.

In *The Merchant of Venice,* Shakespeare combined comic intrigue with a vivid portrait of hatred and greed. Although the play ends happily for everyone except the revengeful Shylock, it is not a light-hearted comedy. In Shakespeare's time, both the church and the state considered moneylending at high interest a crime. Shylock was thus a natural object of scorn. On the surface, Shakespeare's view of him reflected the attitudes of the day. But the dramatist treated the moneylender as a very human and even sympathetic person. For example, Shakespeare provided Shylock with an eloquent statement of how it feels to be part of a harshly treated minority: "If you prick us, do we not bleed? If you tickle us, do we not laugh? If you poison us, do we not die? And if you wrong us, shall we not revenge?"

Henry IV, Parts I and II, two related histories partly based on the *Chronicles* by the English historian Raphael Holinshed and on *The Famous Victories of Henry the Fifth,* a play by an unknown English author. Part I probably first performed in 1597. First published in 1598. Part II probably first performed in 1598. First published in 1600.

The two parts of *Henry IV* dramatize events that follow the murder of England's King Richard II. In Part I, the guilt-ridden Henry IV wants to go to the Holy Land in repentance for Richard's death. But constant political unrest in England prevents him. At the same time, Prince Hal, his son, leads an apparently irresponsible life with his brawling friends, led by the fat, jolly knight Sir John Falstaff. Falstaff's clowning provides most of the play's humor. The king quarrels with Henry Percy, known as Hotspur, who is the fiery young son of the powerful Earl of Northumberland. As a result of the quarrel, the Percy family revolts. At the Battle of Shrewsbury, Hal reveals himself to be a brave and princely warrior and kills Hotspur.

Scene from *Henry IV,* Part I, at the Stratford Festival Theatre, Ont. (De Wys)

Henry IV, a two-part history, is noted for the character of Sir John Falstaff, one of Shakespeare's greatest comic figures. In the plays, Falstaff, *right,* spends much of his time drinking and clowning with his boisterous friends at the Boar's Head Inn.

Part II of *Henry IV* also has many scenes of Falstaff's clowning. These scenes are set against the background of the continuing Percy rebellion and the approaching death of the ill Henry IV. Hal's brother, Prince John, finally defeats the rebels. The king dies, and Hal takes the throne as Henry V. He immediately reveals his royal qualities and rejects Falstaff and his friends, telling them to leave him alone until they have abandoned their wild living.

Of the two plays, Part I is more memorable. It introduces Falstaff, best characterized by his comment in Part II that "I am not only witty in myself, but the cause that wit is in other men." Falstaff is a bragging, lying, and thievish drunkard. But his faults are balanced by his clever sense of humor, his contagious love of life, and his refusal to take either himself or the world seriously. Falstaff is one of the great comic roles in the theater.

As You Like It, a comedy partly based on *Rosalynde,* a novel by the English author Thomas Lodge. Probably first performed in 1599. First published in 1623.

Rosalind and her cousin Celia leave the court of Celia's father, Duke Frederick, after he unjustly banishes Rosalind. Accompanied by Touchstone, the court jester, the two girls take refuge in the Forest of Arden. Also in the forest are Orlando, who loves Rosalind; Jaques, a melancholy philosopher; Audrey, a country girl; Silvius, a shepherd; and Phebe, a shepherdess. Duke Frederick's brother, who is Rosalind's father and the rightful ruler of Frederick's land, also lives in the forest. He leads a band of merry outlaws.

Rosalind, disguised as a young shepherd named Ganymede, meets Orlando in the forest. Not recognizing the disguised girl, Orlando agrees to pretend that Ganymede is Rosalind so he can practice his declarations of love. Rosalind finally reveals her identity and marries Orlando. Oliver, Orlando's formerly wicked brother, marries Celia, Touchstone marries Audrey, and Silvius marries Phebe. The news that Rosalind's father has been restored to his dukedom completes the comedy's happy ending.

Like many other Elizabethan romantic comedies, *As You Like It* concerns young lovers who pursue their happy destiny in a world seemingly far removed from reality. Although evil threatens, it never harms. Shakespeare enriched the play with beautiful poetry as well as several charming songs.

Shakespeare consistently balanced the merry laughter of *As You Like It* with notes of seriousness and even sadness. Touchstone's wit and Jaques's remarks question the nature of love and the values of society. The

play discusses the advantages and disadvantages of city and country life. Jaques adds a strong note of melancholy to the play with his famous description of the seven ages of man. At the end of the description, he claims that man's final fate is "second childishness and mere oblivion, / Sans [without] teeth, sans eyes, sans taste, sans everything."

Henry V, a history partly based on the *Chronicles* by the English historian Raphael Holinshed and on *The Famous Victories of Henry the Fifth,* a play by an unknown English author. Probably first performed in 1599. First published in 1600.

The play continues the action of *Henry IV,* Part II, and presents an idealized portrait of England's King Henry V. The king decides to press a claim he believes he has to the French throne. He heads an army that lands in France. Inspired by Henry's leadership, the outnumbered English troops defeat the French at the town of Harfleur. The two armies then meet in battle near the village of Agincourt. Against overwhelming odds, the English win a great victory. The triumphant Henry is received at the French court. There he is promised the throne and the hand of Katherine, the French princess with whom he has fallen in love.

The play consists of loosely related episodes unified by the character of the brave but modest king. Shakespeare filled *Henry V* with patriotic passages, especially the king's famous address to his troops at Harfleur. It begins, "Once more unto the breach, dear friends, once more." The speech concludes, "The game's afoot! / Follow your spirit; and upon this charge / Cry 'God for Harry! England and Saint George!' "

Henry claims to hate war in general. Yet he finds himself carried away by the glamour and glory of the French campaign. Although the play occasionally seems to glorify war, Shakespeare set the heroics against a background of political treachery and empty honor. Comic scenes mock the vanity of the royal court. These scenes remind audiences that monarchs and their councils plan wars, but ordinary people must fight and die in them.

Julius Caesar, a tragedy partly based on *Lives* by the ancient Greek biographer Plutarch, as translated by the English writer Sir Thomas North. Probably first performed in 1599. First published in 1623.

The play takes place in ancient Rome and concerns events before and after the assassination of the Roman ruler Julius Caesar. In spite of its title, the play's central character is Brutus, a Roman general and Caesar's best friend. Brutus reluctantly joins a plot to murder Caesar because he believes Rome's safety requires his death. The plotters attack Caesar in the Roman Senate. He resists until he sees Brutus. Caesar's last words are "Et tu, Brute? [You too, Brutus?] Then fall, Caesar!"

Brutus defends the assassination to a crowd of Romans. But he unwisely allows the clever and eloquent Mark Antony to deliver a funeral speech over Caesar's body. Antony tells the people, "I come to bury Caesar, not to praise him." He then describes the plotters with heavy sarcasm as "honorable men." At the same time, Antony points out Caesar's virtues and thus gradually turns the crowd into a mob ready to burn and kill in order to avenge Caesar's death. The plotters are forced to flee Rome.

Mark Antony leads an army that defeats the forces of the plotters at the Battle of Philippi. At the end of the battle, Brutus commits suicide. Over his corpse, Antony states, "This was the noblest Roman of them all." Antony says that the other plotters killed Caesar out of envy but only Brutus acted with "honest thought / And common good to all."

Julius Caesar has become a popular play because of its magnificent language and sharp character portraits. For example, Caesar describes the plotter Cassius as having a "lean and hungry look." But the real interest in *Julius Caesar* centers on the character of Brutus. A thoughtful, withdrawn man, he is torn between his affection for Caesar and his strong sense of duty to the state.

Much Ado About Nothing, a comedy partly based on *Orlando Furioso,* an epic poem by the Italian author Ludovico Ariosto, and on a story in *Novelle,* a collection of tales by the Italian author Matteo Bandello. Probably first performed in 1599. First published in 1600.

This romantic comedy concerns the attempts by the villainous Don John to slander the virtue of Hero, the daughter of the governor of Messina, Italy. After a great deal of intrigue, the play ends happily. However, the real interest in *Much Ado About Nothing* centers on the relationship between Beatrice and Benedick, two witty young people who trade insults throughout most of the play. Their arguments and their final discovery that they love each other provide much of the fun of the play. Adding to the gaiety of the play is the broad humor of the talkative village constable, Dogberry, and his assistant, Verges.

Twelfth Night, a comedy partly based on a story in *Farewell to Military Profession,* a collection of tales by the English author Barnabe Riche. Probably first performed in 1600. First published in 1623.

Viola and Sebastian, who are twins, become separated during a shipwreck. Viola finds herself stranded in the country of Illyria. She disguises herself as Cesario, a page, and enters the service of Duke Orsino. The duke sends the page to woo the countess Olivia for him. But the countess falls in love with Cesario. Meanwhile, the page only complicates matters further by falling in love with the duke.

The romantic action alternates with scenes of realistic comedy involving the fat knight Sir Toby Belch and his friends. One friend, Sir Andrew Aguecheek, fights Cesario in a comic duel. Maria, the countess Olivia's lady-in-waiting, tricks the countess' steward, Malvolio, into thinking that Olivia loves him. The plot becomes increasingly tangled until Sebastian, Viola's twin brother, appears. Viola then reveals her identity, and the confusion is resolved. Orsino marries Viola, and Sebastian marries Olivia. Only Malvolio is left unhappy.

In *Twelfth Night,* Shakespeare created a perfect blend of sentiment and humor. In addition, he provided Feste, Olivia's clown, with witty comments on the foolish ways of people. Feste's songs contribute both gaiety and sadness to the mood of the play. In one famous song, he reminds the audience that they should enjoy the present

Scene from a New York Shakespeare Festival production (George E. Joseph)

Much Ado About Nothing is a romantic comedy that centers on Beatrice and Benedick, *left,* two witty young people who trade insults until they finally realize they love each other. In the production above, the setting has been changed from Italy to the United States in the late 1890's.

because nobody can know what the future will bring:

> What is love? 'Tis not hereafter;
> Present mirth hath present laughter;
> What's to come is still unsure:
> In delay there lies no plenty;
> Then come kiss me, sweet and twenty!
> Youth's a stuff will not endure.

Only Malvolio, who thinks he is more moral than other people, spoils the gentle mood of the play. Sir Toby Belch angrily asks him, "Dost thou think, because thou art virtuous, there shall be no more cakes and ale?" The comedy also contains the famous passage "Some are born great, some achieve greatness, and some have greatness thrust upon 'em."

The première of *Twelfth Night* probably took place on the Christian festival known as the Epiphany or Twelfth Night. The festival occurs 12 days after Christmas.

The Merry Wives of Windsor, a comedy possibly based on an unknown source or sources. Probably first performed in 1600. First published in 1602.

This play represents Shakespeare's only attempt to write a realistic comedy. According to a popular though unproven story, Queen Elizabeth requested the play. She so enjoyed the comic character Sir John Falstaff in the *Henry IV* plays that she asked Shakespeare to write a comedy portraying Falstaff in love. The comedy dramatizes Falstaff's efforts to make love to Mistress Ford and Mistress Page, two honest middle-class housewives in the town of Windsor. Instead of winning their love, Falstaff ends up the victim of a number of comical tricks invented by the women.

Although *The Merry Wives of Windsor* lacks the romantic poetry of most Shakespearean comedies, the play is highly entertaining. The Falstaff in this work has less imagination and wit than the Falstaff in the *Henry IV* plays. But the character remains theatrically effective, even though the audience laughs at him rather than with him, as in the earlier plays.

The third period (1601-1608)

Shakespeare wrote his great tragedies during the third period of his artistic development. Except possibly for *Pericles,* every play of this period shows Shakespeare's awareness of the tragic side of life. Even the period's two comedies—*All's Well That Ends Well* and *Measure for Measure*—are more disturbing than amusing. For this reason, they are often called "problem" comedies or "bitter" comedies. *Pericles* represents Shakespeare's first *romance*—a drama that is generally serious in tone but with a happy ending.

During this period, Shakespeare's language shows remarkable variety and flexibility, moving easily back and forth between verse and prose. His language has become a totally dramatic tool that makes possible the skillful psychological portraits which mark this period.

Hamlet, a tragedy partly based on *Hamlet,* a lost play by an unknown English author, and on a story in *Histoires Tragiques,* a collection of tales by the French author François de Belleforest. Probably first performed in 1601. First published in 1603.

Prince Hamlet of Denmark deeply mourns the recent death of his father. He also resents his mother's remarriage to his uncle, Claudius, who has become king. The ghost of Hamlet's father appears to the prince and tells him he was murdered by Claudius. The ghost demands that Hamlet take revenge on the king.

Hamlet broods about whether he should believe the ghost. In his soliloquies, he criticizes himself for not acting against his uncle. He also considers the dangers and rewards of suicide. Hamlet decides to have a band of traveling actors perform "something like the murder

of my father" before the king to see if Claudius will show any guilt. The king's violent reaction to the play betrays his guilt. But Hamlet rejects a chance to kill Claudius while he is on his knees in prayer.

Polonius, the king's adviser, decides to eavesdrop on Hamlet while the prince is visiting his mother in her sitting room. He hides behind a curtain, but Hamlet becomes aware that someone is there. Hamlet stabs Polonius through the curtain and kills him.

Claudius exiles Hamlet to England for killing Polonius. He also sends secret orders that the prince be executed after he arrives in England. But Hamlet intercepts the orders and returns to Denmark. He arrives in time to see the burial of Ophelia, the daughter of Polonius. The girl, whom Hamlet had loved, had gone insane following her father's death and drowned herself.

Laertes, Ophelia's brother, blames Hamlet for the deaths of his sister and father. He agrees to a plot suggested by Claudius to kill Hamlet with a poisoned sword in a fencing match. Laertes wounds Hamlet during the duel and, in turn, is wounded himself by the poisoned weapon. While watching the match, Hamlet's mother accidentally drinks from a cup of poisoned wine Claudius had prepared for Hamlet. Although dying from his wound, Hamlet kills Claudius. At the conclusion of the play, Hamlet, his mother, Claudius, and Laertes all lie dead.

Shakespeare handled the complicated plot of *Hamlet* brilliantly. In this play, he also created perhaps his greatest gallery of characters. The role of Hamlet in particular is considered one of the theater's greatest acting challenges. Shakespeare focused the play on the deep conflict within the thoughtful and idealistic Hamlet as he is torn between the demands of his emotions and the hesitant skepticism of his mind. Hamlet reveals this conflict in several famous and eloquent soliloquies. The best known is his soliloquy on suicide, which begins, "To be, or not to be."

Detail of an oil painting on canvas (1839) by Eugène Delacroix; the Louvre, Paris (Giraudon/Art Resource)

Hamlet is a tragedy about a sensitive young prince in Denmark who feels he must avenge his father's murder. When Hamlet sees that a gravedigger has unearthed the skull of his father's jester, Yorick, the prince begins to face the reality of death.

Troilus and Cressida, a tragedy based on several sources, none of which was a chief source. Probably first performed in 1602. First published in 1609.

The story takes place during the Trojan War, fought between ancient Greece and the city of Troy. It dramatizes the love of the Trojan warrior Troilus for the unfaithful Cressida. The couple pledge their love, but Cressida is unexpectedly sent to the Greek camp in exchange for a Trojan prisoner. There she abandons her vow to Troilus and takes the Greek warrior Diomedes as her lover. The play ends with the death of Troilus' brother, the great Trojan hero Hector.

In spite of its heroic setting, *Troilus and Cressida* is neither noble nor stirring. Except possibly for Hector, all the characters act less than heroically. In both outlook and style, the play has more in common with the problem comedies than with the great tragedies.

All's Well That Ends Well, a comedy partly based on a story in *The Palace of Pleasure,* a collection of tales by various European authors, as translated by William Painter, an Englishman. Probably first performed in 1603. First published in 1623.

This play takes place in France and Italy. Helena, the beautiful orphaned daughter of a physician, loves Bertram, a nobleman. In Paris, Helena cures the French king of an illness and wins Bertram as her husband in reward. But Bertram considers Helena beneath him socially and deserts her immediately after the wedding. He tells her in a letter that she can never call him husband unless she gets a ring from his finger and becomes pregnant by him. Helena fulfills both conditions. One night, unknown to Bertram, she takes the place of a girl for whom her husband has a foolish passion. Bertram finally recognizes his wife's good qualities and promises to love her dearly.

On the surface, *All's Well That Ends Well* resembles other Elizabethan comedies of romantic intrigue. But unlike Shakespeare's earlier comedies, it has little gaiety and romance. Bertram's conduct makes him an unattractive hero. Many critics also dislike Helena for throwing herself at him. The play's interest lies primarily in Shakespeare's efforts to express through comedy his troubled view of humanity's imperfections.

Measure for Measure, a comedy partly based on *Promos and Cassandra,* a play by the English author George Whetstone. Probably first performed in 1604. First published in 1623.

Vincentio, Duke of Vienna, turns over the affairs of the city to Angelo, his stern deputy, and Escalus, a wise old nobleman. The duke hopes the two men will introduce needed moral reforms in Vienna. In one of his first acts, Angelo sentences Claudio to death for making Juliet, his fiancée, pregnant. Claudio's sister, Isabella, pleads with Angelo for Claudio's life. Overcome by her beauty, Angelo agrees to save Claudio if she will allow him to make love to her. Isabella refuses, preferring to let her brother die rather than yield her honor. After much intrigue and plotting, Claudio is saved, Isabella keeps her virtue, and Angelo's wicked deeds are exposed.

Many critics have objected to the happy ending of *Measure for Measure.* They consider it false to the spirit of the play. The first part of the play is serious, almost tragic. The latter part becomes a typical romantic intrigue. This lack of artistic unity creates problems. The first part of the play, for example, seriously raises questions about the nature of justice. But these questions seem to be answered too lightly at the play's end.

In spite of its flaws, *Measure for Measure* has many excellent features. Shakespeare drew the characters of Angelo and Isabella with keen understanding. He also included much broad comedy that is highly effective. In addition, his dramatic poetry at times equals that of the best in his tragedies.

Othello, a tragedy partly based on a story in *Hecatommithi,* a collection of tales by the Italian author Cinthio. Probably first performed in 1604. First published in 1622.

Othello, a noble black *Moor* (North African), has spent his life as a soldier and become a general in the army of Venice, Italy. He marries Desdemona, a beautiful Venetian girl much younger than himself. Almost immediately after the marriage, Othello is ordered to Cyprus, where Desdemona joins him. Othello's villainous aide, Iago, hates the Moor. Iago decides to destroy Othello by persuading him that Desdemona has made love with Cassio, Othello's lieutenant.

Iago quickly convinces Othello that Desdemona has been unfaithful. He achieves his goal by taking advantage of Othello's insecurity over his color, age, and lack of sophistication. Constantly tormented by Iago, Othello murders Desdemona. After the Moor learns he has been tricked, he stabs himself and dies, describing himself as "one that loved not wisely, but too well."

This play is Shakespeare's most straightforward tragedy. The action moves rapidly, and the language is simple and direct, like the main character. *Othello* and *Romeo and Juliet* differ from Shakespeare's other tragedies in that neither deals with public affairs and royalty. Instead, *Othello* is a tragedy of personal tensions, of love and hatred, and of jealousy and impatience.

King Lear, a tragedy partly based on the *Chronicles* by the English historian Raphael Holinshed; *The True Chronicle History of King Leir,* a play by an unknown English author; and *Arcadia,* a romance in prose and verse by the English author Sir Philip Sidney. Probably first performed in 1605. First published in 1608.

The main plot concerns Lear, an aged king of ancient Britain. He prepares to divide his kingdom among his three daughters—Regan, Goneril, and Cordelia. Lear becomes angry when Cordelia, his youngest daughter, refuses to flatter him to gain her portion of the kingdom. Lear rashly disinherits her. He also exiles his trusted adviser, Kent, for supporting Cordelia.

Regan and Goneril soon show their ingratitude. They deprive Lear of his servants and finally force him to spend a night outdoors during a storm accompanied only by his jester, called the Fool. Lear's mind begins to snap under the strain. But as he approaches madness, he finally sees his errors and selfishness. Cordelia, who had been living in France, returns to Britain and finds the king insane. Lear recovers his sanity and recognizes her. Armies raised by the wicked sisters capture Lear and Cordelia, who is put to death. Meanwhile, Goneril has poisoned Regan in a bitter quarrel over a man they both love and then killed herself. Order is finally restored in the kingdom. But Lear dies of a broken heart as he kneels over the body of Cordelia.

Shakespeare skillfully wove a subplot into the main story of Lear and his daughters. Gloucester, a nobleman in Lear's court, makes the mistake of banishing his faithful son, Edgar, and trusting his wicked son, Edmund. Edmund soon betrays his father, who is blinded by Regan's husband. Edgar discovers his blind father and comforts him. Gloucester realizes his errors and especially his lack of concern for people less fortunate than himself. He then dies.

In *King Lear,* Shakespeare created the brilliant characterizations that mark his dramas at their best. The characters realize their mistakes, which reflects Shakespeare's basic optimism. But they do so too late to prevent their destruction and that of the people around them. This fact is at the heart of Shakespeare's tragic view of humanity.

Macbeth, a tragedy partly based on the *Chronicles* by the English historian Raphael Holinshed. Probably first performed in 1606. First published in 1623.

This play is set in Scotland. Returning from battle with his companion Banquo, the nobleman Macbeth meets some witches. They predict that Macbeth will first become *thane* (baron) of Cawdor and then king of Scotland. Macbeth privately has had ambitions of being king. After the first part of the witches' prophecy comes true, he begins to think the second part may also come true. Encouraged by Lady Macbeth, his wife, Macbeth murders King Duncan, a guest in his castle. Macbeth then seizes the throne of Scotland.

But Macbeth has no peace. Duncan's sons have escaped to England, where they seek support against Macbeth. In addition, the witches had also predicted that Banquo's descendants would be kings of Scotland. Macbeth therefore orders the murder of Banquo and his son, Fleance. Macbeth's men kill Banquo, but Fleance escapes. Macbeth is now hardened to killing. He orders the murder of the wife and children of his enemy Macduff, who had fled to England after Duncan's murder. Macduff then gathers an army to overthrow Macbeth. By this time, Lady Macbeth, burdened with guilt over the murders, has become a sleepwalker. She finally dies. At the end of the play, Macduff kills Macbeth in battle. Duncan's son Malcolm is then proclaimed king of Scotland.

In *Macbeth,* Shakespeare wrote a tragedy of a man's conscience. During the course of the play, Macbeth changes from a person of strong but imperfect moral sense to a man who will stop at nothing to get and keep what he wants. By the play's end, Macbeth has lost all emotion. He cannot even react to his wife's death, except to conclude that life is only "a tale / Told by an idiot, full of sound and fury, / Signifying nothing." On the other hand, Lady Macbeth encourages murder in the beginning. But her conscience grows as her husband's lessens. In addition to its psychological insights, *Macbeth* has many passages of great poetry. The play is also

noted for its bitter humor, which reinforces the tragic action.

Timon of Athens, a tragedy partly based on *Lives* by the ancient Greek biographer Plutarch, as translated by the English writer Sir Thomas North. Probably first performed in 1607. First published in 1623.

Timon is a nobleman in ancient Athens. Surrounded by flatterers, he spends his money extravagantly. But after he becomes penniless, his friends desert him. Their ingratitude turns Timon into a bitter person who hates humanity. Timon leaves Athens and goes to live in a cave near the sea, where he finds a buried treasure. But his new-found wealth brings him no happiness. He dies, still a bitter man, in the cave.

Although *Timon of Athens* has flaws, it also has passages of great eloquence. Several such passages occur when Timon pours out his scorn for humanity. Throughout the play, Shakespeare portrays people at their worst, with few of the honorable qualities that lighten the gloom in his great tragedies.

Pericles, a romance partly based on a story in *Confessio Amantis,* a collection of European tales retold by the English poet John Gower. Probably first performed in 1607. First published in 1609.

The action in *Pericles* covers many years and ranges over much of the ancient Mediterranean world. The plot deals with the adventures of Prince Pericles of Tyre. It tells of his marriage, the apparent loss of his wife and daughter, and his rediscovery of them. The play is notable for the characters of the virtuous Pericles and his equally virtuous daughter, Marina. The most moving scene in *Pericles* comes near the end of the play, when Pericles and Marina meet and recognize each other after years of separation.

The play consists of many loosely related episodes and is uneven in quality. Scholars disagree over how much of *Pericles* Shakespeare actually wrote. But the majority believe he wrote most or all of it.

Antony and Cleopatra, a tragedy partly based on *Lives* by the ancient Greek biographer Plutarch, as translated by the English writer Sir Thomas North. Probably first performed in 1607. First published in 1623.

Mark Antony, together with Octavius and Lepidus, rules the Roman Empire. Antony lives in Roman-conquered Egypt, where he has taken the Egyptian queen, Cleopatra, as his mistress. Political problems in Rome and the death of his wife force Antony to leave his life of pleasure and return home. Back in Rome, he marries Octavius' sister Octavia for political reasons. But Antony soon returns to "his Egyptian dish." Octavius then prepares for war against him.

Antony decides unwisely to fight Octavius at sea. During the battle, Cleopatra's fleet deserts him, and Antony flees with the queen. After Cleopatra's ships desert him in a second battle, Antony finally realizes that he has lost everything. Cleopatra deceives him into thinking that she is dead, and Antony stabs himself. But before he dies, he learns that Cleopatra is still alive. Antony then returns to her and dies in her arms. Cleopatra dresses herself in her royal robes, presses a poisonous snake to her breast, and dies of its bite.

The dazzling poetry of *Antony and Cleopatra* is one of the tragedy's most notable features. Early in the play, Enobarbus, one of Antony's officers, gives a famous description of Cleopatra that begins, "The barge she sat in, like a burnished throne, / Burned on the water." Cleopatra is Shakespeare's finest female portrayal. At one moment she is playful, then sulking, and then filled with deadly anger. As Enobarbus says:

> Age cannot wither her, nor custom stale
> Her infinite variety. Other women cloy
> The appetites they feed, but she makes hungry
> Where most she satisfies. . . .

Shakespeare's dramatic use of poetry reveals Antony and Cleopatra from various points of view. On one level, they are merely two people exhausted by a life of excessive pleasure and luxury. On another level, they are tragic characters willing to risk kingdoms for their love. Shakespeare laughs at them for their foolishness, sympathizes with them for their suffering, and admires them for their moments of personal nobility.

Coriolanus, a tragedy partly based on *Lives* by the ancient Greek biographer Plutarch, as translated by the English writer Sir Thomas North. Probably first performed in 1608. First published in 1623.

Caius Marcius, a general in ancient Rome, wins the name Coriolanus after he captures Corioli, the capital city of a people known as the Volscians. Coriolanus returns to Rome in triumph and is nominated for the important office of consul. But he cannot hide his scorn for the common people, whose support he needs to become consul. Coriolanus' superior attitude leads to his exile. He joins forces with his old enemy, the Volscian general Tullus Aufidius, and heads an army against Rome. Coriolanus' mother, wife, and young son meet him outside the city and beg him to spare it. Moved by their pleas, Coriolanus withdraws his troops. Aufidius denounces him as a traitor and has him murdered.

In *Coriolanus,* Shakespeare raised issues that remain particularly important today. The tragedy questions the values of personal popularity and political success. It also debates the conflicting interests of public and private life. Shakespeare's direct and dramatic verse contributes to the play's power.

The fourth period (1609-1613)

During his final period, Shakespeare wrote four plays —three comedies and a history. Most scholars label these three comedies and *Pericles* as his romances. Shakespeare probably wrote the history, *Henry VIII,* with John Fletcher.

The three romances are beautifully constructed, and their poetry ranks among Shakespeare's finest writing. But unlike his masterpieces of the third period, the romances seem detached from reality. Scholars disagree on the reason for this change in Shakespeare's works. Some claim he was calmly looking back on his life and philosophically summing up his career. Other scholars believe that Shakespeare wrote the romances to suit the changing tastes of his audience. They feel that these dramas reflect the growing popularity of plays that mixed comic and serious qualities. The romances probably represent both a change in Shakespeare's attitude to-

ward life and an attempt to follow theatrical fashions.

Cymbeline, a romance partly based on several sources, none of which was a chief source. Probably first performed in 1609. First published in 1623.

Cymbeline, king of Britain, angrily exiles the poor but honorable Posthumous after the young man marries Imogen, the king's daughter. The treacherous Iachimo bets Posthumous that Imogen is not virtuous. Iachimo then tries to make love to her. He fails but tricks Posthumous into believing that Imogen let him do so. Posthumous orders his wife killed, but she escapes disguised as a court page. After many adventures, Imogen and her husband are happily reunited. Iachimo, filled with regret, confesses his wickedness.

The characters in *Cymbeline* are expertly drawn. Imogen in particular is one of Shakespeare's most appealing heroines. The play also has a lively, melodramatic plot. The plot moves close to tragedy but never quite touches the tragic level.

The Winter's Tale, a romance partly based on *Pandosto,* a prose romance by the English author Robert Greene. Probably first performed in 1610. First published in 1623.

Leontes, king of Sicilia, becomes uncontrollably jealous of his faithful wife, Hermione. He has her imprisoned and orders that their newborn daughter, Perdita, be abandoned in some isolated place. Leontes finally realizes that he has no cause for jealousy. But his conduct has cost him his friends and family, including his wife, who has fallen into a deathlike faint.

Meanwhile, Perdita has been saved by an old shepherd. She grows into a lovely young girl and wins the love of Florizel, prince of Bohemia. But Florizel's father angrily disapproves of their romance, and the couple flee to Leontes' court for protection. There, Leontes discovers that Perdita is his daughter. The king's happiness is complete when he is also reunited with his wife, whom he thought was dead. She had actually been living alone while hoping for the return of Perdita.

Like *Cymbeline, The Winter's Tale* concerns exile, women suffering from male jealousy, and the reuniting of loved ones. Also like the earlier play, *The Winter's Tale* takes a potentially tragic situation and uses it to stress rebuilding rather than destruction. The characters in this drama, made wiser by their sad experiences, happily face the future.

The Tempest, a romance partly based on several sources, none of which was a chief source. Probably first performed in 1611. First published in 1623.

Prospero, the wrongfully exiled Duke of Milan, Italy, lives on an enchanted island with his beautiful daughter, Miranda. The mischievous spirit Ariel and the monster Caliban serve Prospero, who is a skilled magician. Using magic, Prospero creates a *tempest* (storm) that causes a ship carrying his enemies to be wrecked on the island. The ship also carries the young prince Ferdinand. Miranda loves him at first sight and cries out, "O brave new world that hath such creatures in it." With his magic, Prospero brings Miranda and Ferdinand together and upsets plots laid against him by his shipwrecked enemies. Prospero appears before his enemies and forgives them. He decides to give up his magic and return to Italy, where Ferdinand and Miranda can be married.

American Shakespeare Theatre, Stratford, Conn (Martha Swope)

The Tempest was Shakespeare's last great comedy. The play takes place on an enchanted island ruled by Prospero, a magician, *center.* Prospero lives there with his daughter, Miranda, *right,* and his unwilling slave, the monster Caliban, *left.*

Like *Cymbeline* and *The Winter's Tale, The Tempest* tells a story in which old injuries are forgiven and the characters begin a new and happier life. In *The Tempest,* Shakespeare blended spectacle, song, and dance with a romantic love story, beautiful poetry, and broad comedy. The result of this blending is a brilliant dramatic fantasy. In one of Shakespeare's most famous speeches, Prospero tells the audience:

> Our revels now are ended. These our actors,
> As I foretold you, were all spirits and
> Are melted into air, into thin air;
> And, like the baseless fabric of this vision,
> The cloud-capped tow'rs, the gorgeous palaces,
> The solemn temples, the great globe itself,
> Yea all which it inherit, shall dissolve,
> And, like this insubstantial pageant faded,
> Leave not a rack behind.

Many scholars have taken these lines to be Shakespeare's farewell to his profession. But no one knows if he intended the speech to be autobiographical.

Henry VIII, a history partly based on the *Chronicles* by the English historian Raphael Holinshed and on *The Book of Martyrs,* a religious work by the English author John Foxe. Probably first performed in 1613. First published in 1623.

The play dramatizes the events that led to England's break with the Roman Catholic Church. It deals with King Henry VIII's divorce of Catherine of Aragon (Katherine of Aragon in the play) and his marriage to Anne Boleyn. The play also covers the fall of Cardinal Wolsey as the king's adviser and the rise of Archbishop Cranmer as Wolsey's replacement. *Henry VIII* is a loosely constructed drama and better known for its pageantry than for its characterization. It has passages of splendid verse, but the work as a whole does not show Shakespeare at the height of his creative powers.

Shakespeare wrote two long poems, *Venus and Adonis* and *The Rape of Lucrece.* Both are *narrative* poems—that is, they tell a story. Shakespeare also composed a sequence of 154 sonnets and a short poem called "The Phoenix and the Turtle."

The narrative poems

Venus and Adonis (1593) is partly based on the *Metamorphoses,* a collection of tales in verse by the ancient Roman poet Ovid. The poem tells how Venus, the goddess of love, tries to win the love of the handsome young mortal Adonis. He resists her and is finally killed by a wild boar while hunting.

Shakespeare wrote *Venus and Adonis* in six-line stanzas. Most of the lines have five accented syllables. The lines of *Venus and Adonis* rhyme *ababcc,* which means the first and third lines rhyme, as do the second and fourth, and the fifth and sixth.

The poem is witty and filled with sexual references. But the work is most notable for its vivid settings and its formal and elaborate speeches. *Venus and Adonis* represents Shakespeare's successful attempt to write the kind of love poetry that was popular among literary members of the royal court.

The Rape of Lucrece (1594) is also partly based on the works of Ovid, as well as on writings by other authors. The poem tells of Lucrece, the virtuous wife of a Roman nobleman. She is sexually attacked by the lustful general Tarquin. After the rape, Lucrece demands that her husband and his friends swear to revenge her ruined honor. She then kills herself.

Shakespeare wrote *The Rape of Lucrece* in seven-line stanzas, each line having five accents. The lines rhyme *ababbcc.* The poem is more serious in tone than *Venus and Adonis.* The work has little action and, like the earlier poem, depends greatly on long flowery speeches for its effect.

The sonnets

In the late 1500's, it was fashionable for English gentlemen authors to write sequences of sonnets. Some sonnet sequences followed a narrative pattern that was autobiographical in varying degrees. For this reason, scholars have tried to learn about Shakespeare's life from his sonnets. But they have reached no general agreement on autobiographical information that the poems might contain.

Scholars generally do agree, however, that Shakespeare addressed the first 126 sonnets to a young nobleman and that the next 26 concentrate on a woman. But they have not been able to identify either person. They have long debated over the nature of Shakespeare's relationship with the young man and have come to no general conclusion. Many scholars believe that Shakespeare had a passionate but somewhat reluctant love affair with the woman. Because the poems describe the woman as a brunette, she has become known as the "dark lady" of the sonnets. Sonnets 153 and 154 seem unrelated to the others, and some scholars doubt that Shakespeare wrote them.

Composition and publication. Shakespeare probably wrote the sonnets over a period of several years, though their dates are not clear. He wrote the poems in three units of four lines each with a concluding *couplet* (two-line unit). Shakespeare's sonnets rhyme *abab cdcd efef gg.*

Two of the sonnets originally appeared in a book of poetry called *The Passionate Pilgrim* (1599). Thomas Thorpe published the sonnets as a collection in 1609. Thorpe dedicated the book to Mr. W. H., whom he called "the only begetter of these ensuing sonnets." Scholars do not know who Mr. W. H. was or even if he inspired the poems or merely collected them for the publisher. The individual poems have no titles. Scholars refer to them either by their first line or by the number Thorpe assigned to them.

Themes. In the sonnets addressed to his aristocratic friend, Shakespeare treated a variety of subjects. "Shall I compare thee to a summer's day?" (sonnet 18) praises physical beauty. "When, in disgrace with Fortune and men's eyes" (sonnet 29) describes the power of friendship to cheer the poet. Some of the sonnets are particularly notable for their wit, as in "That time of year thou mayst in me behold" (sonnet 73).

In several of the first 126 sonnets, Shakespeare referred to another poet he considered a rival for his young friend's affection and support. Scholars have called this person the "rival poet." They do not know who he was or if he even existed.

The sonnets' most common themes concern the destructive effects of time, the quickness of physical decay, and the loss of beauty, vigor, and love. Although the poems celebrate life, it is always with a keen awareness of death. This awareness of death is perhaps best expressed in "Poor soul, the center of my sinful earth" (sonnet 146).

A distrust of love and human nature runs through the "dark lady" sonnets. Sonnet 138, which appears below, reflects this attitude. In addition, the poem is representative of the entire sequence in two ways. The sonnet tells of the poet's concern over the passing of time, and it shows his strong emotion controlled by his highly intellectual wit.

When my love swears that she is made of truth
I do believe her, though I know she lies,
That she might think me some untutored youth,
Unlearned in the world's false subtleties.
Thus vainly thinking that she thinks me young,
Although she knows my days are past the best,
Simply I credit her false-speaking tongue:
On both sides thus is simple truth suppressed.
But wherefore says she not she is unjust?
And wherefore say not I that I am old?
O, love's best habit is in seeming trust,
And age in love loves not to have years told.
Therefore I lie with her and she with me,
And in our faults by lies we flattered be.

"The Phoenix and the Turtle"

This 67-line poem appeared in 1601 in a collection called *Love's Martyr.* It praises ideal love, using as symbols two birds, the phoenix and the turtledove. The poem has philosophical and symbolic qualities that have led to various biographical, political, and religious interpretations by critics.

Shakespeare and other Elizabethan writers looked upon the English language as alive and changing. They did not consider it fixed for all time in a set of correct and unbreakable rules. Shakespeare experimented freely with sentence structure and vocabulary to create special effects. He also used various literary devices to present information and ideas in a dramatic and appealing way. But Shakespeare's style is perhaps best known for its brilliant use of language to create vivid pictures in the mind.

Shakespeare's style has helped shape the language of all English-speaking countries. This influence has chiefly been felt directly through his writings. But it has also been felt through the interest his work has aroused in the literature of the Elizabethan period in general. Many later writers in English have accepted the Elizabethan style as their model. As a result, much English and American literature reflects the highly individualized enthusiasm of most Elizabethan writing.

Vocabulary. Shakespeare changed words, invented words, and borrowed words from other languages. He even used nouns as verbs for dramatic effect. In *Measure for Measure,* for example, a character remarks that Angelo "dukes it well," referring to the forceful way in which Angelo handles the duties of the absent Duke of Vienna. Shakespeare also used verbs in both their modern form—for example, *has*—and in their older form—*hath.* In the same way, Shakespeare used both modern pronouns, such as *you,* and older pronouns, such as *thee* or *thou.*

Some of Shakespeare's words may be unfamiliar or confusing to modern readers and theatergoers. His vocabulary basically resembles modern English, but he employed many words that are no longer used. Readers and theatergoers may also be puzzled by familiar words that had additional or different meanings in Shakespeare's time. In *Othello,* for example, Iago raises a "shrewd doubt" about Desdemona's faithfulness. In this case, "shrewd" means "serious" or "grave," not its modern meaning, "clever." Most editions of Shakespeare's plays include notes that define such words.

Rhetoric. Shakespeare and other Elizabethan writers enjoyed using *rhetoric*—special literary devices that present a fact or idea in a dramatic and interesting manner. Indeed, authors were often more concerned with how something was said than with what was actually said.

Shakespeare used many kinds of rhetorical devices that writers still use. One familiar kind is *alliteration,* in which the same sound is repeated in a line or group of lines of verse. When Juliet tells Romeo that "parting is such sweet sorrow," the *s* sounds of the last three words provide alliteration. Shakespeare also frequently used a rhetorical device called *repetition.* Hamlet's cry against his stepfather "O villain, villain, smiling, damned villain!" shows effective dramatic use of repetition.

Shakespeare's rhetoric became more skillful as he matured as a playwright. In his early play *Richard III,* for example, much of the repetition is artificial and awkward. But in his later plays, Shakespeare used repetition naturally and effectively. An example can be shown from *Othello.* The Moor, carrying a candle, looks at his sleeping wife and prepares to murder her. He utters the simple and moving sentence "Put out the light, and then put out the light." He then proceeds to debate the finality of death before he smothers his wife. This rhetorical device is called *antanaclasis,* which means the repetition of a certain word or phrase but with a deliberate shift in its meaning.

Like other poets, Shakespeare often used *metaphor*—a figure of speech in which two different things are compared. In *As You Like It,* for example, Jaques begins a famous soliloquy with a metaphor:

> All the world's a stage,
> And all the men and women merely players.
> They have their exits and their entrances,
> And one man in his time plays many parts,
> His acts being seven ages.

Shakespeare enjoyed using *puns* (humorous plays on words). In *Cymbeline,* he wrote, "Golden lads and girls all must, / As chimney-sweepers, come to dust." The lines express the serious thought that even beautiful young people must grow old and die, but the pun adds a light touch. In *Henry V,* Pistol, an English soldier fighting in France, says, "To England will I steal, and there I'll steal."

Imagery. The richness and precision of Shakespeare's imagery give his writing its unique style. A famous example of his brilliant imagery comes from *Macbeth.* Horrified by his murder of King Duncan, Macbeth looks at his bloodstained hands and says:

> What hands are here? Ha! They pluck out mine eyes!
> Will all great Neptune's ocean wash this blood
> Clean from my hand? No. This my hand will rather
> The multitudinous seas incarnadine,
> Making the green one red.

The image of Duncan's blood turning all the oceans *incarnadine* (blood-red) reveals the terrifying sorrow Macbeth feels over committing the murder.

Another vivid example of Shakespeare's imagery appears in *Richard II.* Richard warns Bolingbroke that his rebellion against the king will bring the horrors of civil war to England:

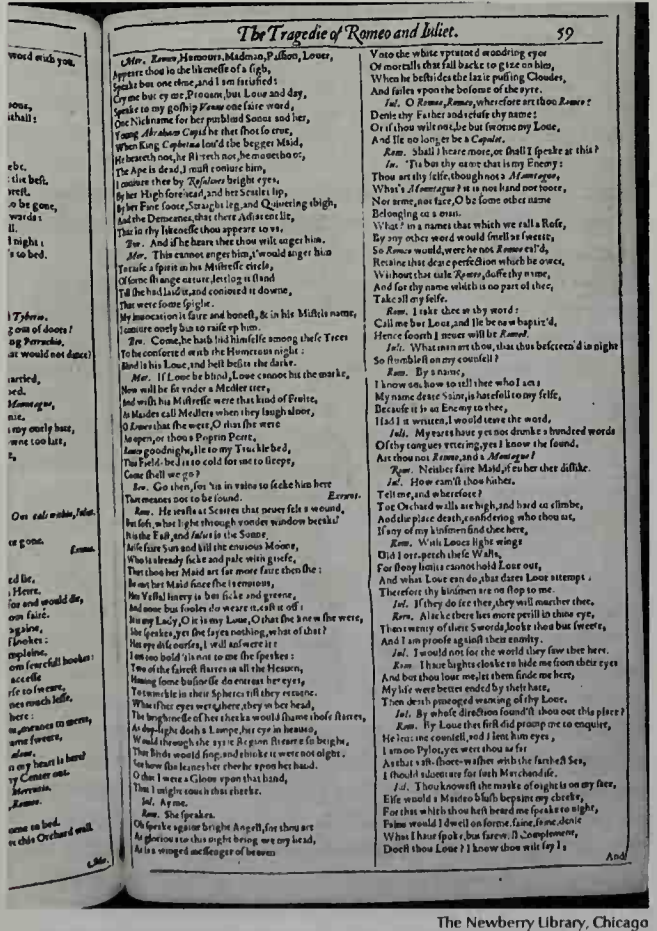
> He is come to open
> The purple testament of bleeding war.
> But ere the crown he looks for live in peace,
> Ten thousand bloody crowns of mothers' sons
> Shall ill become the flower of England's face,
> Change the complexion of her maid-pale peace
> To scarlet indignation, and bedew
> Her pastures' grass with faithful English blood.

Verse form. Shakespeare reinforced his imagery with the rhythm of his verse. He composed his plays largely in blank verse—that is, in lines of unrhymed iambic pentameter. In such a pattern, each line is divided into five units called *feet,* with the accent falling on every second syllable. Of all English metrical patterns, blank verse—particularly when occasionally varied—comes closest to the rhythms of everyday speech. In his earliest plays, much of Shakespeare's blank verse was stiff and artificial. But it soon developed into a completely flexible dramatic instrument. Through his verse, Shakespeare could create a feeling of speed and excitement or a sense of calm dignity.

No manuscripts of Shakespeare's plays exist. As a result, modern editions of the plays must be based on early published texts. There are two kinds of these texts, *quartos* and *folios*. A quarto is a small volume containing one Shakespeare play. A folio is a large volume of his collected plays. Nineteen of Shakespeare's plays first appeared in quarto form. For his remaining 18 plays, a folio is the only source.

The publishing history of Shakespeare's plays has been a story of constant attempts by editors to correct errors in the quartos and folios. Editors have also tried to explain difficult words and phrases in the light of new historical information.

Quartos have been classified as *good quartos* and *bad*, or *pirated, quartos*. The good quartos were probably printed either from Shakespeare's own manuscripts or from reasonably accurate copies of them. Generally, the good quartos provide a clear and readable text, though Elizabethan printing was careless by modern standards. The bad quartos are shortened versions of the plays. They differ sharply from folio and good quarto texts. The bad quartos have so many errors that in places they are almost meaningless. These quartos were published without permission from Shakespeare's company. Scholars generally agree that the texts were reconstructed from memory by one or more actors who had appeared in the plays.



The Tragedie of Romeo and Iuliet. 59

Mer. Romeo, Mercutio, Madman, Page, Louer,
Appeare thou in the likenesse of a sigh,
Speake but one rime, and I am satisfied:
Cry but ay me: Pronoune, but Loue and day,
Speake to my gossip Venus one faire word,
One Nickname for her purblind Sonne and her,
Young Abraham Cupid he that shot so true,
When King Cophetua lou'd the beggar Maid,
He heareth not, he stirreth not, he moueth not,
The Ape is dead, I must coniure him,
I coniure thee by Rosalines bright eyes,
By her High forehead, and her Scarlet lip,
By her Fine foote, Straight leg, and Quiuering thigh,
And the Demeanes, that there Adiacent lie,
That in thy likenesse thou appeare to vs.
Ben. And if he heare thee thou wilt anger him.
Mer. This cannot anger him, t'would anger him
To raise a spirit in his Mistresse circle,
Of some strange nature letting it there
Till she had laid it, and coniured it downe,
That were some spight.
My inuocation is faire and honest, & in his Mistris name,
I coniure only but to raise vp him.
Ben. Come, he hath hid himselfe among these Trees
To be consorted with the Humorous night:
Blind is his Loue, and best befits the darke.
Mer. If Loue be blind, Loue cannot hit the marke,
Now will he sit vnder a Medler tree,
And wish his Mistresse were that kind of Fruite,
As Maides call Medlers when they laugh alone.
O Romeo that she were, O that she were
An open, or thou a Poprin Peare,
Romeo goodnight, I le to my Truckle bed,
This field-bed is too cold for me to sleepe,
Come shall we go?
Ben. Go then, for 'tis in vaine to seeke him here
That meanes not to be found. Exeunt.
Rom. He iests at Scarres that neuer felt a wound,
But soft, what light through yonder window breaks?
It is the East, and Iuliet is the Sunne.
Arise faire Sun and kill the enuious Moone,
Who is already sicke and pale with griefe,
That thou her Maid art far more faire then she:
Be not her Maid since she is enuious,
Her Vestal liuery is but sicke and greene,
And none but fooles do weare it, cast it off:
It is my Lady, O it is my Loue, O that she knew she were,
She speakes, yet she sayes nothing, what of that?
Her eye discourses, I will answere it:
I am too bold, 'tis not to me she speakes:
Two of the fairest starres in all the Heauen,
Hauing some businesse do entreat her eyes,
To twinkle in their Spheres till they returne.
What if her eyes were there, they in her head,
The brightnesse of her cheeke would shame those starres,
As daylight doth a Lampe, her eye in heauen,
Would through the ayrie Region streame so bright,
That birds would sing, and think it were not night.
See how she leanes her cheeke vpon her hand.
O that I were a Gloue vpon that hand,
That I might touch that cheeke.
Iul. Ay me.
Rom. She speakes.
O speake again bright Angell, for thou art
As glorious to this night being ouer my head,
As is a winged messenger of heauen

Vnto the white vpturned wondring eyes
Of mortalls that fall backe to gaze on him,
When he bestrides the lazie puffing Clouds,
And sailes vpon the bosome of the ayre.
Iul. O Romeo, Romeo, wherefore art thou Romeo?
Denie thy Father and refuse thy name:
Or if thou wilt not, be but sworne my Loue,
And I le no longer be a Capulet.
Rom. Shall I heare more, or shall I speake at this?
Iul. 'Tis but thy name that is my Enemy:
Thou art thy selfe, though not a Montague,
What's Montague? it is nor hand nor foote,
Nor arme, nor face, O be some other name
Belonging to a man.
What? in a names that which we call a Rose,
By any other word would smell as sweete,
So Romeo would, were he not Romeo call'd,
Retaine that dear perfection which he owes,
Without that title Romeo, doffe thy name,
And for thy name which is no part of thee,
Take all my selfe.
Rom. I take thee at thy word:
Call me but Loue, and I le be new baptiz'd,
Henceforth I neuer will be Romeo.
Iul. What man art thou, that thus bescreen'd in night
So stumblest on my counsell?
Rom. By a name,
I know not how to tell thee who I am:
My name deare Saint, is hatefull to my selfe,
Because it is an Enemy to thee,
Had I it written, I would teare the word.
Iul. My eares haue yet not drunke a hundred words
Of thy tongues vttering, yet I know the sound.
Art thou not Romeo, and a Montague?
Rom. Neither faire Maid, if either thee dislike.
Iul. How camst thou hither,
Tell me, and wherefore?
The Orchard walls are high, and hard to climbe,
And the place death, considering who thou art,
If any of my kinsmen find thee here.
Rom. With Loues light wings
Did I orre-perch these Walls,
For stony limits cannot hold Loue out,
And what Loue can do, that dares Loue attempt:
Therefore thy kinsmen are no stop to me.
Iul. If they do see thee, they will murther thee.
Rom. Alacke there lies more perill in thine eye,
Then twenty of their Swords, looke thou but sweete,
And I am proofe against their enmity.
Iul. I would not for the world they saw thee here.
Rom. I haue nights cloake to hide me from their eyes
And but thou loue me, let them finde me here,
My life were better ended by their hate,
Then death prorogued wanting of thy Loue.
Iul. By whose directions found'st thou out this place?
Rom. By Loue that first did prompt me to enquire,
He lent me counsell, and I lent him eyes,
I am no Pylot, yet were thou as far
As that vaste shore-washe with the farthest Sea,
I should aduenture for such Merchandize.
Iul. Thou knowest the maske of night is on my face,
Else would a Maiden blush bepaint my cheeke,
For that which thou hast heard me speake to night,
Fain would I dwell on forme, fain, fain deny
What I haue spoke, but farewell Complement,
Doest thou Loue? I know thou wilt say I:
And

The Newberry Library, Chicago

The First Folio was the earliest edition of Shakespeare's collected plays. The book was published in London in 1623. A page from the tragedy *Romeo and Juliet* is reproduced here.

Folios. The first edition of Shakespeare's collected plays is called the *First Folio*. Isaac Jaggard, a printer, and Edward Blount, a bookseller, published the volume in 1623, seven years after Shakespeare died. The book contains all Shakespeare's accepted plays except *Pericles*. John Heminge and Henry Condell, former members of Shakespeare's company, assembled the plays. In the introduction, they wrote that the plays were "absolute in their numbers, as he [Shakespeare] conceived them." Although the First Folio does not quite live up to this statement, it remains an outstanding publishing achievement for its time.

Heminge and Condell obtained the texts of the plays from various sources, including quartos and playhouse *promptbooks*. A promptbook was a copy of the script with detailed directions for performing the play. The First Folio was followed by the Second Folio (1632), the Third Folio (1663-1664), and the Fourth Folio (1685). The final three folios show attempts at editorial corrections, but they are not considered dependable texts.

Editions of the 1700's and 1800's. During the 1700's, several English editors worked to produce better texts of Shakespeare's plays. Nicholas Rowe made the first important attempt with a multivolume edition published in 1709. Other notable editors of the 1700's, with the year in which their edition appeared, included Alexander Pope (1725), Lewis Theobald (1733), Samuel Johnson (1765), Edward Capell (1768), and Edmund Malone (1790). Theobald's edition is particularly important for its many corrections that try to restore the text to its original meaning. Johnson's edition is significant for its scholarly comments on the plays themselves.

The first *variorum* editions of the plays appeared during the 1800's. Variorum editions include notes by previous editors as well as alternate versions of disputed passages. The most elaborate edition is the *New Variorum* edited by H. H. Furness and others. The first volume was published in 1871. The project is still in progress.

In the 1800's, the most important edition of the plays probably was the nine-volume *Cambridge Shakespeare* (1863-1866) edited by W. G. Clark, J. Glover, and W. Aldis Wright. In 1864, the edition was published in a single volume. Known as *The Globe Shakespeare*, it became the standard work for scholarly reference.

Modern Shakespeare editions show an increased awareness of the social and intellectual background against which Shakespeare worked. Modern editors also have been able to interpret difficult passages and resolve textual problems with more confidence than earlier editors could. This confidence has resulted from new knowledge gained about printing and publishing during the Elizabethan Age.

Modern multivolume editions included the *New Arden Shakespeare* (1951-1982) and the *New Penguin Shakespeare* (1967-1988). In the early 1980's, Cambridge University and Oxford University began issuing new editions that will reflect the latest computer-assisted textual scholarship. Several single-volume editions also provide dependable texts and helpful comments. They include *The Complete Pelican Shakespeare* (1969), *The Riverside Shakespeare* (1974), and *The Complete Works of Shakespeare* (1980), edited by David Bevington.

Shakespearean criticism—that is, serious analysis of Shakespeare and his works—did not begin until the late 1600's. During Shakespeare's lifetime, Robert Greene apparently attacked Shakespeare for thinking he could write as well as university-educated playwrights. Francis Meres considered Shakespeare the best English stage dramatist for comedy and tragedy. The First Folio, which appeared in 1623 after Shakespeare's death, contained a number of poems praising Shakespeare. The poems included a famous tribute by the playwright Ben Jonson. Jonson said of Shakespeare, "He was not of an age, but for all time!" But all these comments cannot be considered formal criticism.

Neoclassical criticism. Scholars have traditionally called the period of English literature from 1660 to 1798 the neoclassical period. During this period, drama criticism was heavily influenced by the theories of the ancient Greek philosopher Aristotle. Neoclassical critics believed that Aristotle had established certain rules for writing drama. Many of these critics were bothered by Shakespeare's failure to follow these rules. For example, Shakespeare often broke the neoclassical rule against mixing comedy with tragedy. Most of the critics concluded, however, that Shakespeare was unaware of Aristotle's theories and so could be excused for ignoring them.

A landmark of neoclassical criticism of Shakespeare appeared in John Dryden's *An Essay of Dramatic Poesy* (1668). This work is usually considered the first serious criticism of the dramatist. In the essay, Dryden compared Shakespeare with Ben Jonson. Dryden wrote that he admired Jonson for being "the more correct poet." However, he loved Shakespeare, who "needed not the spectacles of books to read Nature" but "looked inwards, and found her there."

The most sensible neoclassical criticism came from the writer Samuel Johnson. He praised Shakespeare for holding up a "faithful mirror of manners and of life." He also recognized the universal appeal of Shakespeare's plays. At the same time, Johnson criticized what he considered to be Shakespeare's weaknesses. For example, Johnson objected to many comic sexual passages, which he considered vulgar.

In his influential *An Essay on the Dramatic Character of Sir John Falstaff* (1777), Maurice Morgann tried to show that Falstaff was not really a coward, as other critics claimed. Morgann analyzed the comic figure in great detail, as if Falstaff were a real person. Many later critics also came to regard Shakespeare's major characters as actual people independent of the plays.

Romantic criticism. A movement called romanticism began to influence English literature significantly about 1798. Its influence lasted through most of the 1800's. The romantic critics tended to glorify Shakespeare almost as a god who could do no wrong. Some romantic critics believed that Shakespeare's plays should properly be studied as nondramatic literature and not simply as works for the stage.

In spite of their one-sided view of Shakespeare's genius, the romantics produced many outstanding works of criticism. These works included Charles Lamb's *On the Tragedies of Shakespeare* (1811) and William Hazlitt's *Characters of Shakespeare's Plays* (1817). The lectures and essays of Samuel Taylor Coleridge also rank as landmarks of Shakespearean criticism.

Romantic criticism reached a climax with two books. The first was Edward Dowden's *Shakspere: A Critical Study of His Mind and Art* (1875). The book attempts to relate the moral problems posed in the plays to Shakespeare's own experience with those problems. The second influential book was A. C. Bradley's *Shakespearean Tragedy* (1904). Bradley examined *Hamlet, Othello, King Lear,* and *Macbeth* and tried to show that the major characters behave in a psychologically valid way.

Modern critics have profited greatly from modern scholarship in all areas of Shakespeare's life, times, and writings. The following discussion deals with some of the major contributions that British and American scholars have made to modern Shakespearean criticism.

Many scholars have concentrated on the study of Shakespeare's early texts to bring critics closer to what the playwright actually wrote. The leading textual scholars of the early 1900's include W. W. Greg, R. B. McKerrow, A. W. Pollard, and J. Dover Wilson.

Modern scholars have also explored the conditions under which Shakespeare's plays were first produced. They have done research on the theater buildings, the actors, and the audiences. Joseph Quincy Adams' *Shakespearean Playhouses* (1917) and E. K. Chambers' four-volume *The Elizabethan Stage* (1923) provided the basis for many later studies. The most important of these studies include Alfred Harbage's *Shakespeare's Audience* (1941) and John Cranford Adams's *The Globe Playhouse* (1942). However, many of Adams's conclusions have been challenged by later scholars.

Modern scholarship has resulted in a variety of critical approaches to Shakespeare's plays. E. E. Stoll studied the plays in terms of Elizabethan theatrical traditions. Lily Bess Campbell, Hardin Craig, Theodore Spencer, and E. M. W. Tillyard analyzed the plays in the light of Elizabethan ideas on history, philosophy, and psychology. Harley Granville-Barker wrote a series of essays called *Prefaces to Shakespeare* (1927-1947). In these essays, Granville-Barker examined the plays as works for the stage and rejected the romantic belief that the plays should be studied rather than performed.

In the 1930's, critics began to show strong interest in Shakespeare's imagery. In *Shakespeare's Imagery and What It Tells Us* (1935), Caroline Spurgeon attempted to discover Shakespeare's beliefs and his likes and dislikes through his imagery.

A number of modern critics have used psychological theory to try to penetrate the surface of the action and understand the subconscious motives of both the characters and the author. Ernest Jones, a psychoanalyst, took this approach in *Hamlet and Oedipus* (1949). Jones's book helped shape many interpretations of the plays presented on the modern stage and in motion-picture versions.

Jan Kott, a Polish critic, wrote an unusual study of the plays called *Shakespeare Our Contemporary* (1964). In this work, he tried to approach Shakespeare's plays from the pessimistic point of view of much literature of the mid-1900's.

Frank W. Wadsworth

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Poetry (Forms)
Stratford-upon-Avon

Outline

I. **Shakespeare's life**
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Questions

Why are *Measure for Measure* and *All's Well That Ends Well* called *problem comedies*?
How has Shakespeare influenced the English language?
What are some common themes of Shakespeare's sonnets?
How did public and private theaters differ in Shakespeare's day?
Why has there been any question about the authorship of Shakespeare's plays?
What part did the Wars of the Roses play in Shakespeare's histories?
What was the *First Folio*?
What attitude did the romantic critics have toward Shakespeare and his plays?
Into what three groups are Shakespeare's plays traditionally divided? What is an example from each group?
Why did Shakespeare turn to writing narrative poetry in the early 1590's?

Additional resources

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Shale is a fine-grained sedimentary rock formed by the compression of muds. This type of rock is composed primarily of quartz and minerals that are found in clay. Shales can be broken easily into thin, parallel layers. Shale is ground up for use in making bricks and cement. See also **Earth** (Earth's three kinds of rocks); **Oil shale; Sedimentary rock; Slate.** Finley C. Bishop

Shallot, *shuh LAHT* or *SHAL uht,* is a vegetable that looks and tastes like an onion. People eat shallots in salads and use them as seasoning for cooked foods. The entire plant is edible, including its leaves, stems, and bulb. The bulb consists of several small sections called *cloves,* which are joined at the plant's base.

Shallot plants can grow from year to year without being replanted. But most commercial producers grow shallots by replanting bulbs from the previous harvest. The bulbs are harvested in winter or in spring. They are then dried and stored until they are replanted.

The most popular variety is a disease-resistant type called Louisiana Pearl. Louisiana produces most of the shallots grown in the United States. George R. Hughes

Scientific classification. The shallot is a member of either the amaryllis family, Amaryllidaceae, or the lily family, Liliaceae. Its scientific name is *Allium ascalonicum.*

Shaman, *SHAH muhn,* is a person considered to have powers that come from direct contact with the supernatural, often in dreams or trances. The term *shaman* came from a Mongolian word. However, peoples in many areas have shamans who they believe cast out evil spirits or bring good, especially by curing disease. Shamans may be found among the Inuit (sometimes called Eski-

mos), Maori, Mongolians, Polynesians, and other peoples. American Indians had similar beliefs (see Indian, American [Shamans]). Jennie Keith

Shamir, *shah MEER,* **Yitzhak,** *YIHTS zhahk* (1915-), served as prime minister of Israel from October 1983 to September 1984, and from October 1986 to July 1992. As prime minister, he continued most of Israel's established foreign policies. For example, he supported Jewish settlements in the West Bank and Gaza Strip—territories that Israeli troops had occupied in 1967.

Shamir succeeded Menachem Begin as prime minister in 1983, after Begin had resigned. He also replaced Begin as head of the political party called the Likud bloc. Shamir had been foreign minister since 1980.

In Israel's parliamentary elections of July 1984, no party won a majority. In September, the Likud bloc and the Labor Party formed a unity government that lasted for 50 months. Under the unity government agreement, Shimon Peres, leader of the Labor Party, served as prime minister for 25 months. Shamir served as vice prime minister and foreign minister. Under the agreement, the roles of Peres and Shamir were reversed after 25 months—in October 1986. In the elections of November 1988, no party won a majority. In December, Likud and Labor formed a new coalition government. Shamir remained prime minister.

In 1988, protests by Palestinians in the occupied territories began erupting into violence. Several hundred Palestinians and a smaller number of Israelis were killed. In 1990, Shamir refused to compromise on peace plans for the territories. The Labor Party then left the coalition, and the government fell in March. In June 1990, Likud and small conservative parties formed a new coalition government in Israel with Shamir as prime minister. The Labor Party won control of the parliament in elections held in June 1992. In July, Labor Party leader Yitzhak Rabin replaced Shamir as prime minister. Shamir resigned as head of the Likud bloc in March 1993. In 1999, he left Likud and joined the right-wing Herut Party.

Shamir was born on Oct. 15, 1915, in Ruzinoy, Poland (now Ruzhany, Belarus). His last name was Jazernicki. He later changed it to Shamir, the Hebrew word for both *thistle* and *flint.* He studied law in Warsaw before moving to Palestine in 1935 to attend Hebrew University. He dropped out in 1937 and joined the Irgun Zvai Leumi, an underground Jewish militia that fought the British—who then ruled Palestine—and the Palestinian Arabs.

In 1940, Shamir joined the more radical Lohamei Herut Yisrael (Israel Freedom Fighters), or Stern Gang, militia. The nation of Israel was created in Palestine in 1948. From 1955 to 1965, Shamir worked for Mossad, Israel's intelligence agency. He was first elected to the *Knesset* (Israeli parliament) in 1973. Malcolm C. Peck

Shamrock is a type of small herb with leaves made up of three leaflets. It is the national symbol of Ireland. According to legend, Saint Patrick planted shamrock in Ireland because the three small leaflets represented the Holy Trinity. Many Irish people wear a shamrock on St. Patrick's Day. The name *shamrock* comes from an Irish word that means *trefoil* (three-leafed).

In Ireland, the plant most often referred to as shamrock is the *white clover.* This plant has slender, creeping stems and white or pinkish-white flowers. Other plants that are sometimes referred to as shamrock include *red clover* and *black medic.* Florists often sell *wood sorrel* as shamrock. But this plant is generally not considered the traditional shamrock. Roy E. Gereau

Scientific classification. White clover, red clover, and black medic belong to the pea family, Leguminosae. The scientific name for white clover is *Trifolium repens.* Red clover is *T. pratense,* and black medic is *Medicago lupulina.* Wood sorrel is in the oxalis family, Oxalidaceae. It is *Oxalis acetosella.*

WORLD BOOK illustration by Lorraine Epstein

Shamrock

Shang dynasty, *shahng,* was the earliest known Chinese *dynasty* (family of rulers). The dynasty governed from about 1766 B.C. to about 1045 B.C. It was centered in what is now northern Henan Province.

The Shang society, though based on agriculture, became famous for its fine carvings and bronze work. Most Shang relics found by scientists came from Anyang, a Shang capital. Anyang had houses, palaces, temples, and elaborate tombs.

The people of the Shang period used bronze to make vessels, weapons, and chariot fixtures. They also carved jade and wove silk. The Shang writing system, an early form of Chinese, had more than 3,000 symbols. It appears on pieces of bone and on turtle shells. The people used oracle bones to ask the spirits of their ancestors about such future occurrences as crop raising, hunting trips, and wars.

The Shang society was headed by a priest-king and had two classes of people—commoners and nobles. The people worshiped their ancestors and had many gods, including Di, their highest god. They sometimes practiced human sacrifice. For example, slaves were buried alive in the tombs of their masters. Grant Hardy

See also China (History [map]); World, History of the (The Huang He Valley).

Shanghai, *SHANG hy* (pop. 8,205,598), is the largest city in China and a center of industry, trade, and finance. It lies on the Huangpu River in the eastern part of China. About 14 miles (23 kilometers) north of Shanghai, the Huangpu and Yangtze rivers meet and empty into the East China Sea. Shanghai's location near these important waterways helps make it China's leading port and industrial city. For location, see China (political map).

Shanghai was a small trading town until the 1800's. In 1842, the United Kingdom forced China to open it to foreign trade. People from France, the United Kingdom, the United States, and other countries settled in Shanghai and gained power in the city's affairs. They made Shanghai a world leader in trading and banking. They built homes, churches, and office buildings that gave much of Shanghai a Western appearance. The Chinese Communists took over the city and the rest of China in 1949.

The city. Most of the people of Shanghai are Chinese. The city lies within the Shanghai special municipal district, which has a population of about 13 million. The district has three main parts. They are (1) the old foreign section in the north, (2) the original Chinese settlement in the south, and (3) suburban areas. The district also

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Shanghai's Pudong area is an economic center of the city and also a world center of banking and finance. The Pudong area, with its many high-rise office buildings, lies on the east side of the Huangpu River.

includes several rural counties and offshore islands.

The heart of Shanghai lies in the old foreign section, near the intersection of the Bund and Nanjing Road. The Bund is a broad boulevard with dozens of skyscrapers. It lies along the Huangpu River. Nanjing Road has many stores and restaurants. The People's Plaza, a large square on Nanjing Road, was once the site of a British race track. It is now the city's largest public open space and the site of the Shanghai Museum. The Shanghai Museum houses an impressive collection of Chinese art. Its exhibits include Chinese paintings, bronzes, sculptures, ceramics, jade carvings, furniture, and coins.

The original Chinese settlement, sometimes called the "Chinese City," lies south of the foreign section. This area has narrow, twisting streets.

Since the middle of the 1900's, the Chinese government has built a number of suburbs around old Shanghai. These areas include apartments, factories, farms, schools, and shops.

Economy. Shanghai lies in one of China's most important industrial areas. Iron mines west of the city help supply raw material for the manufacture of machinery and for shipbuilding. Textile mills make cloth from cotton grown in the nearby Yangtze Valley or from imported cotton. The city's other products include cement, electrical equipment, and fertilizer. Farmers in Shanghai suburbs grow cereal grains, cotton, and vegetables. They also raise pigs and fish. Shanghai has a stock market and is a center of finance and trade. The city is also the home of many universities and research centers.

Government. Shanghai lies in Jiangsu Province, but because it is a special municipal district, its government is independent of the provincial government. China's special municipal districts are administered by the national government.

History. Shanghai developed as a small trading center during the Song dynasty (960-1279). In 1842—at the end of the Opium War between China and the United Kingdom—the United Kingdom forced China to open the town to foreign trade. Other nations soon gained trading rights, and Shanghai became a major trading center. British, French, Japanese, and U.S. citizens settled there in special areas for foreigners called *concessions*.

Foreigners and some Chinese business people set up banks and businesses in Shanghai. Many Chinese peasants moved to the city to find jobs. Most Chinese workers lived in slums in the old part of the city.

During the early 1900's, merchants, students, and workers protested against foreign influence. Some of them founded China's Communist Party in Shanghai in 1921. In 1927, the Chinese Nationalists killed many Chinese Communists and drove others from the city.

The Japanese captured Shanghai in 1937 and occupied it until World War II ended in 1945. The United Kingdom and the United States gave up their concessions there during the war. France gave up its in 1946.

The Communists conquered China in 1949. They enlarged Shanghai and developed heavy industries. In 1966, Communist Party Chairman Mao Zedong called for a "cultural revolution" to rid the party of his enemies. As part of this revolution, *Red Guards* (student supporters of Mao) drove the Shanghai government from power. In January 1967, during what was called the "January Revolution," a committee directed by China's army took control of the city's government. In 1979, Shanghai was returned to civilian rule.

During the 1990's, Shanghai experienced a building boom. The city added thousands of residential and commercial buildings and opened a subway system. Shanghai also developed its Pudong area, which lies on the east side of the Huangpu River. The Pudong area has become an economic center of the city as well as an international financial center. The 88-story Jin Mao Building in the Pudong area is China's tallest building and one of the tallest buildings in the world. It measures 1,380 feet (421 meters). Frederic Wakeman, Jr.

Shanker, Albert (1928-1997), was president of the American Federation of Teachers (AFT) from 1974 until his death. He became one of the nation's most influential educational leaders.

In 1964, Shanker was elected president of the United Federation of Teachers (UFT), a New York City union. Under his leadership, the UFT conducted strikes against the city in 1967, 1968, and 1975. These strikes gained higher pay, better working conditions, and job security for teachers. Shanker served as vice president of the American Federation of Labor and Congress of Industrial Organizations (AFL-CIO) from 1973 until his death.

Shanker was born on Sept. 14, 1928, in New York City. He graduated from the University of Illinois, earned a master's degree from Columbia University, and then taught elementary school mathematics. He began to work full-time in the teachers' union movement in 1959. He died on Feb. 22, 1997. James G. Scoville

Shannon, River, is the longest river and chief waterway of the Republic of Ireland. It rises in the Cuilcagh Mountains of northwestern Ireland and flows southwest about 230 miles (370 kilometers) to the Atlantic Ocean (see Ireland [terrain map]). Three major *loughs* (lakes)—Allen, Ree, and Derg—lie along its course. At Limerick, about 70 miles (110 kilometers) from the Shannon's mouth, the river widens. Ocean tides occur in this section, on which there are ports at Limerick and Foynes. The river is a major waterway for pleasure cruising. Ireland's largest river hydroelectric plant was built on the Shannon between Lough Derg and Limerick in the 1920's. The Grand and Royal canals, built in the late 1700's and early 1800's, link the river with Dublin, on Ireland's east coast. Desmond A. Gillmor

Shapiro, *shuh PEER oh,* **Karl Jay** (1913-2000), was an American poet. In *Person, Place and Thing* (1942), he defended the blessings of individuality *(person)* against conformity; the searching examination of society *(place)* in contrast to uncritical allegiance; and the richness of the created *thing* as opposed to destruction.

Shapiro won the 1945 Pulitzer Prize for poetry with *V-Letter and Other Poems.* His essays often express rebellion against rules for making or judging art. His *Essay on Rime* (1945) and *The Bourgeois Poet* (1964) denounce the style of life and poetry, including his own, that lies within the safety of middle-class attitudes and formal verse. His poetry appeared in *New and Selected Poems, 1940-1986* (1987). He also wrote a novel, *Edsel* (1971).

Shapiro was born in Baltimore on Nov. 10, 1913. He was the editor of the periodicals *Poetry* from 1950 to 1955 and *Prairie Schooner* from 1956 to 1966. He died on May 14, 2000. Bonnie Costello

Shapley, Harlow (1885-1972), was an American astronomer. He made important studies of *variable stars* (stars that change in brightness) and the spherical stellar groups in which they frequently occur. His research on these star groups, called *globular clusters,* contributed much to knowledge about the Milky Way and other galaxies, such as the Magellanic Clouds.

By studying variable stars known as *Cepheid variables,* Shapley determined that many globular clusters occur near the center of the Milky Way Galaxy. He then calculated the approximate distance of the sun from this concentration of clusters. He found that the sun was closer to the edge of the Galaxy than to its center, as astronomers had believed. Shapley's achievements included the discovery of two star systems belonging to an important type of distant galaxy called a *dwarf galaxy.*

Shapley was born on Nov. 2, 1885, in Nashville, Missouri. He earned a Ph.D. degree from Princeton University in 1913. He served as director of the Harvard Observatory from 1921 to 1952. Shapley died on Oct. 20, 1972. Raymond E. White

Shar-pei. See Chinese shar-pei.

Sharaku, *shah RAH koo,* was a great Japanese artist of the late 1700's. His reputation rests on color woodcuts of Japanese actors that he created in 1794 and 1795. Nothing is known of his life before and after these years or why his career was so short. Sharaku was the artist's professional name. His real name is unknown.

Sharaku portrayed actors of the Japanese *kabuki* drama playing their roles. Most of his prints are head portraits. Sharaku exaggerated the facial features and distorted the postures of his subjects. His prints capture the likenesses of the actors and the spirit of their dramatic roles. Robert A. Rorex

Portrait of Bando Mitsugoro (1794 or 1795); Tokyo National Museum (Museum-Shuppan Co., Ltd.)

A Sharaku woodcut portrays a Japanese actor playing a role in a kabuki drama. A typical Sharaku print exaggerates an actor's facial features and posture to capture the spirit of the role.

See also Japanese print (picture: Theatrical prints); Woodcut.

Share. See Stock, Capital.

Sharecropper. See Plantation.

**Sharī`a,** *shuh REE uh,* is the legal and moral code of Islam. Muslims believe that the Sharī`a, also spelled Sharī`ah, is divinely inspired. It is the law of the land in the Islamic countries of Saudi Arabia and Iran, and it exerts great influence in other Islamic countries and cultures. *Sharī`a* is an Arabic word that originally meant *a path to a source of water,* which suggests purity and nourishment. It has come to be understood as *The way that leads to God.*

The Sharī`a is a system of morals, religious observance, ethics, and politics. It covers both religious and nonreligious aspects of life. For example, the Sharī`a includes guidelines on how Muslims wash, eat, pray, maintain friendships, conduct business, and govern. In religious matters, the interpretation of the Sharī`a has remained largely unchanged over the years. But in social, political, and cultural affairs, it has undergone considerable interpretation by generations of Islamic scholars.

The Sharī`a is based on several sources. The most important are the Islamic holy book called the Qur'ān and

the *Sunna,* which is the example demonstrated by the sayings and acts of the prophet Muhammad. The Sunna is preserved in written collections called the *Hadith.* For the majority of Muslims, the nature of the Sharī`a is determined by *ijma,* which is a general agreement of views among religious scholars. But among followers of the Shi'ah division of Islam, the guidance and example of leaders called Imams was considered more important.

The formal method for determining points of practice and procedure according to the Sharī'a is the discipline of *fiqh* (law). This discipline and the basic interpretations of the Sharī`a developed during the second and third centuries of Islamic history. That period corresponds to the A.D. 700's and 800's. Hugh Talat Halman

See also **Islam** (Teachings and practices); **Quran.**

Shark is a meat-eating fish and one of the most feared sea animals. Scientists classify about 360 species of fish as sharks. These fish live in oceans throughout the world but are most common in warm seas.

Sharks vary greatly in size and habits. Whale sharks, the largest kind of shark—and the largest of all fish—may grow up to 40 feet (12 meters) long. They may weigh over 15 tons (14 metric tons), more than twice as much as an average African elephant. The smallest sharks may measure about 6 inches (16 centimeters) long and weigh about 1 ounce (28 grams).

Some kinds of sharks live in the depths of the ocean. Others swim near the surface. Some species of sharks live in coastal waters, but others dwell far out at sea. A few species enter rivers and lakes that have outlets to the sea. Scientists believe that one species, the Ganges River shark of India and Pakistan, lives only in rivers.

All sharks are *carnivores* (meat-eaters). Most of them eat live fish, including other sharks. In fact, a shark's most common natural enemy is a larger shark. Most sharks eat their prey whole, or they tear off large chunks of flesh. Some sharks crush their prey. Others scoop out small pieces of flesh from large fish. Sharks also feed on dead or dying animals. Sharks have the reputation of attacking human beings. But fewer than 100 shark attacks a year are reported throughout the world.

The body of a shark

Sharks differ from other kinds of fish in a number of ways. For example, sharks have a boneless skeleton made of a tough, elastic substance known as *cartilage.* Most species of sharks have a rounded body, shaped somewhat like a torpedo. This streamlined shape helps sharks to swim. Angel sharks, which live near the ocean bottom, have a flat body similar to that of skates and rays.

Sharks have fewer young at a time than most fish do. Some shark species give birth to 60 or more *pups* in a litter, but most have far fewer. The parents do not take care of the young—and may even eat them.

The eggs of sharks, unlike those of most fish, are fertilized inside the female's body. The male has two organs called *claspers,* which release sperm into the female, where it fertilizes the eggs. Among most shark species, the eggs hatch inside the female, and the pups are born alive. At least 40 species lay their eggs outside their bodies.

Tail and fins. Sharks can travel with great bursts of speed when excited. The fastest-swimming sharks have a crescent-shaped tail that provides power for swimming. The upper part of the tail usually is longer than the lower part. Stiff *pectoral fins* (side fins) help lift and balance the front of the body.

Most fish have a *swim bladder,* a gas-filled organ that helps them remain at a certain depth without sinking. Sharks lack this organ. Instead, they have a large liver filled with oil. This oil is lighter than water, and it helps the shark keep from sinking. Even so, most sharks must swim constantly or they will sink.

Teeth and scales. A shark's mouth is on the underside of the head among all species except the angel, megamouth, whale, and wobbegong sharks. The mouth of these sharks is at the front of the head. A shark has several rows of teeth. New teeth replace the older ones regularly—as often as every week in some species. Some sharks have molarlike grinding teeth. Others have razorlike grinding teeth, and still others have pointed

Peter Lake from Peter Schub

The oceanic whitetip shark, *shown here,* has a graceful, torpedolike body. The fish's streamlined shape enables it to move swiftly through the water with little effort. This shark is named for the white markings on the tips of its fins. It is one of the most common species of large shark.

teeth. Some people believe that sharks must turn over on their back to bite, but this is not true.

Small, toothlike scales cover a shark's body. These *placoid* scales make the skin of a shark rough. Dried sharkskin, called *shagreen,* was once used as sandpaper.

Gills. Sharks get oxygen from the water through gills, as do other fish. But sharks have no *gill cover,* a bony plate that shields the gills of most fish. Instead, sharks have from five to seven slits in the skin on each side of the head. Water passes out of these slits after the shark's gills remove the oxygen. Many sharks cannot pump water over their gills, as do the majority of fish. These sharks rely on their constant swimming to force water through their mouth and over their gills. This process of forcing water is known as *ramjet ventilation.*

Senses. Sharks have keen senses that help them compete successfully for prey. They have excellent hearing, though it is limited to low-pitched sounds. Sharks can home in on prey by its sounds. Some scientists believe that the shark's *lateral line* detects the lowest-pitched sounds. The lateral line is a sensory system of fluid-filled canals that runs down both sides of the shark's body, from its head to its tail. The lateral line, sometimes called *distant touch,* also detects water movement.

Sharks have highly sensitive eyes that can see well in dim light. Sharks even possess a crude form of color vision. However, they may not be able to see details clearly. Sharks have been called "swimming noses." It was once widely believed that sharks relied mainly on their sense of smell to hunt prey. However, little evidence exists of a special sensitivity for smells in sharks.

Sharks can detect very small electrical fields. The head of a shark has many small pores that lead to an elaborate system of sensory tubes. These tubes, called *ampullae of Lorenzini,* are sensitive to electrical fields. Sharks can locate and capture a fish by sensing the small electrical field produced by its gills. Sharks also seem to use their electrical sense for navigation and migration.

Kinds of sharks

Sharks belong to a group of fishes known as *elasmobranchs.* Rays and skates also belong to this group. Scientists do not know exactly how many kinds of sharks there are. They occasionally identify new species. But sometimes they find that two sharks that had been considered different species are actually the same. This section describes some of the best-known sharks.

Basking sharks may measure over 30 feet (9.1 meters) long and live in tropical and temperate waters. They eat only small water organisms called *plankton.* These sharks have a habit of slowly swimming on the surface. They seem to be *basking* (warming themselves), but they are actually filtering plankton from the surface.

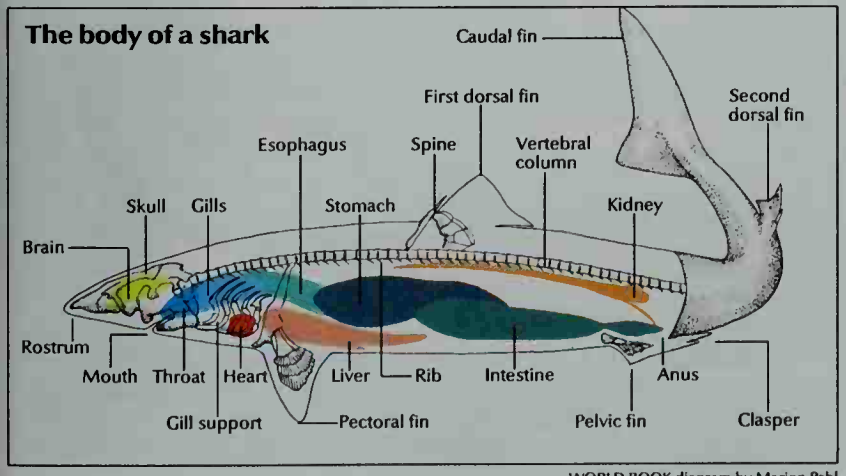
Bull sharks can live in fresh water. They often enter rivers that empty into the sea. For example, bull sharks have been captured in the Amazon River in Brazil, in the Ganges River in India, and in the Mississippi River in the United States. They are also found in Lake Jamor in Indonesia and in Lake Nicaragua in Nicaragua. Bull sharks often feed on other sharks and have attacked swimmers.

Hammerhead sharks, which include a number of similar species, rank among the strangest-looking sharks. They have a flattened head, which in most of the species resembles the head of a hammer. Their eyes and nostrils are at the ends of the "hammer." The largest hammerhead, the great hammerhead, may grow as much as 20 feet (6.1 meters) long. Hammerheads live in shallow tropical and warm temperate waters and have attacked people.

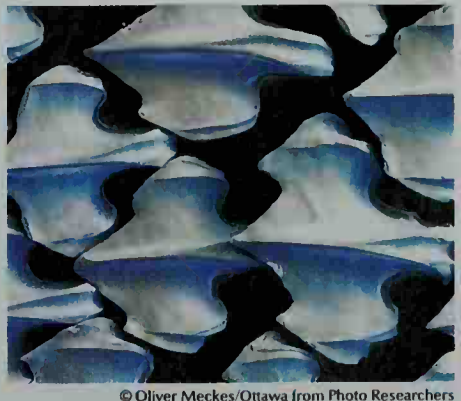
Mako sharks are swift, powerful creatures. They are considered one of the best species of game fish among all the sharks. When hooked, a mako fights by leaping high into the air. Most makos live in tropical and warm temperate waters. They may reach a length of 12 feet (3.7 meters). Makos feed on such fish as bluefish, herring, mackerel, and swordfish. Makos have attacked small fishing boats as well as swimmers.

Nurse sharks are slow-moving fish that may grow to 14 feet (4.3 meters) long. They live among reefs in shallow tropical and subtropical waters. Unlike most species of sharks, the nurse shark can pump water over its gills. Therefore, it does not have to swim constantly and often lies motionless on the sea bottom. Nurse sharks eat bottom-dwelling fish, crabs, lobsters, and shrimp. They have attacked people. But most of these attacks were caused by the victim, who foolishly grabbed a motionless nurse shark by the tail.

Thresher sharks are long-tailed subtropical fish that swim along the surface. They grow to a length of about 20 feet (6.1 meters), of which half is the tail. The thresher uses its long tail to gather into "herds" the fish it feeds on and to stun fish before eating them. No thresher



WORLD BOOK diagram by Marion Pahl



© Oliver Meckes/Ottawa from Photo Researchers

A shark's skin is covered with tiny toothlike scales. The scales pictured here were photographed with an electron microscope.

Marine Studios, Marineland of Florida

The mouth of a white shark has two working rows of razor-sharp teeth. New teeth regularly replace the old teeth. The replacement teeth lie out of sight along the inside of the jaws.

shark has been known to attack a person.

Whale sharks, in spite of their enormous size, eat only plankton and small fish. Therefore, they are harmless to people. Whale sharks live in tropical waters.

White sharks rank among the most dangerous sharks. They measure up to 21 feet (6.4 meters) long and live in cool temperate to tropical waters. White sharks swim powerfully and prey on such large animals as sea lions, tuna, and other sharks. They have attacked human beings and even fishing boats.

Sharks and people

Shark attacks. About 50 species of sharks are considered potentially dangerous to human beings. Most shark attacks do not result in death or serious injury. However, swimmers should take special care in areas known to have sharks.

People once thought that sharks ate constantly and would attack any human being immediately. But scientists have learned that some species of sharks can go for days or weeks without feeding. During this time, the oil stored in their liver probably nourishes them.

Scientists do not know why sharks sometimes attack people and at other times leave them alone. The American Elasmobranch Society studies shark attacks throughout the world. The society supports safety rules for people who swim in water where sharks may be nearby. These rules include the following:

(1) Never swim or dive alone.

(2) Never swim or dive with an open wound. Blood attracts sharks.

(3) Never swim or dive at night or in dirty water, where there is less chance of spotting a shark.

(4) Leave the water immediately if a shark is sighted. Swim as smoothly as possible because thrashing movements might attract the shark.

(5) Never grab or injure any shark, even a small and apparently harmless one.

How people use sharks. Commercial fishing crews catch sharks mainly for their hides, fins, and flesh. Shark hide makes an especially luxurious leather after the scales have been removed. Chinese people often use dried shark fins to make a popular and expensive soup.

People in various parts of the world eat the flesh of many species of sharks. In England, for example, dogfish sharks are often used in preparing *fish and chips,* which consists of fried fish and French fried potatoes.

The liver oil of certain species of sharks contains much vitamin A. Until the late 1940's, when scientists discovered an inexpensive way to manufacture vitamin A, shark liver oil ranked as a main source of this vitamin.

Since the late 1950's, sharks have been used increasingly in scientific research. Medical researchers are particularly interested in the fact that few sharks have ever been found with a cancerous tumor. Scientists hope to discover what protects sharks from disease.

Commercial shark fishing increased during the 1980's, partly because shark fins brought high prices in Asian markets. Fishing crews caught so many sharks that populations dwindled worldwide. Conservationists feared that many shark species would become extinct.

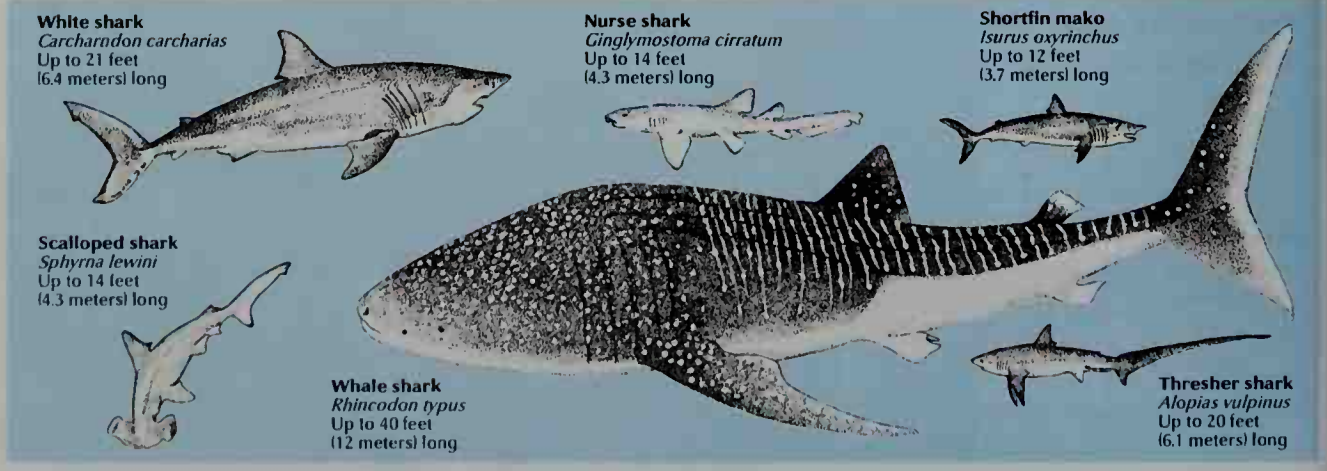
During the 1990's, some countries began to protect sharks. South Africa, for example, declared great white sharks a protected species and banned fishing for great whites or selling their jaws or other body parts. The United States issued rules in 1993 to protect 39 species of sharks in U.S. waters. The rules included commercial fishing quotas, bag limits for sport fishing, and a ban on catching several species, including the great white shark and whale shark.

Samuel H. Gruber

Scientific classification. Sharks belong to the class Chondrichthyes. Basking, mako, and white sharks are in the family Lamnidae; hammerhead sharks, the family Sphyrnidae; thresher sharks, the family Alopiidae; and whale sharks, the family Rhin-

Some kinds of sharks

WORLD BOOK illustration by Marion Pahl



codontidae. Bull sharks are in the family Carcharhinidae. Nurse sharks are in the family Orectolobidae.

Related articles in *World Book* include:

Dogfish	Ray
Fish (with pictures)	Whale shark
Hammerhead shark	White shark

Additional resources

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Sharon, *shah ROHN,* **Ariel,** *AIR ee uhl* (1928-), the leader of the conservative Likud party, became prime minister of Israel in 2001. Sharon, nicknamed Arik, has been known as an outspoken critic of the Oslo peace process between Israel and the Palestinians. The Oslo process produced a number of agreements between 1993 and 2001. Sharon also has strongly supported Jewish settlements in the West Bank and Gaza Strip, territories that Israel occupied in 1967.

Sharon was born in Kfar Malal, a Jewish cooperative farming settlement near Tel Aviv in what was then Palestine. As a teen-ager, he joined an underground Jewish defense force that had been set up to protect Jewish settlers from Arab raiding parties. From 1948 to 1973, he served in the Israel Defense Forces, where he rose through the ranks. He eventually became a major general in 1967. He fought in the Israeli war of independence in 1948, the Sinai campaign of 1956, the Six-Day War of 1967, and the Yom Kippur War of 1973. Among some people, he gained a reputation for bravery. Others, particularly Palestinians, considered him ruthless.

AP/Wide World

Ariel Sharon

In 1973, Sharon resigned from the military and entered politics. He was first elected to the Knesset (Israeli Parliament) that same year. He held a number of Cabinet posts, including minister of agriculture in charge of settlements from 1977 to 1981 and minister of defense from 1981 to 1983. As defense minister, he directed the Israeli invasion of Lebanon in June 1982 in retaliation for terrorist attacks on northern Israel by members of the Palestine Liberation Organization (PLO). The invasion was intended to eliminate the military threat to Israel's northern border. Sharon was criticized for failing to try to prevent a massacre of hundreds of Palestinian civilians in September 1982 by members of the Lebanese Christian militia in the Israeli-occupied part of Beirut. He was forced to resign as defense minister in February 1983 after an Israeli commission that investigated the massacre declared him indirectly responsible for the incident. Sharon went on to serve in other Cabinet roles.

In 1999, Sharon was elected head of the Likud party. In September 2000, he made a controversial visit to the Temple Mount in Jerusalem. The Temple Mount, known to Muslims as Haram al-Sharif, is a holy site for both Jews and Muslims. Disagreement over who would govern the site, as well as other parts of Jerusalem, was a major stumbling block in peace talks between Israel and the Palestinians. Sharon's visit angered Palestinians. Violent clashes broke out between Palestinian protesters and Israeli troops in Palestinian areas of the West Bank and Gaza Strip after Sharon's visit. The continuing violence led Israeli Prime Minister Ehud Barak to call for an election for prime minister to be held in February 2001. In the election, Sharon defeated Barak. Bernard Reich

Shasta, Mount. See Mount Shasta.

Shasta Dam, on the Sacramento River 9 miles (14 kilometers) northwest of Redding, California, is one of the highest concrete dams in the United States. It is a feature of the Central Valley Project in California. Its spillway drops 480 feet (146 meters), making it the highest overflow dam in the world. The reservoir created by Shasta Dam provides irrigation water and electric power. The dam is 602 feet (183 meters) high, 3,460 feet (1,055 meters) long, and contains about 6 $\frac{1}{4}$ million cubic yards (4 $\frac{3}{4}$ million cubic meters) of concrete and about 2 $\frac{1}{4}$ million cubic yards (1 $\frac{3}{4}$ million cubic meters) of earth. The reservoir extends 35 miles (56 kilometers) from the dam up the Sacramento, Pit, and McCloud rivers. It has a capacity of 4 $\frac{1}{2}$ million acre-feet (5.6 billion cubic meters). The United States Bureau of Reclamation built Shasta Dam in 1945. Edward C. Pritchett

See also **Lake** (picture).

Shavuot, *shah VOO oht* or *shah voo OHT,* is a Jewish festival that celebrates the day the Ten Commandments—the foundation of Jewish written and oral law—were revealed to Moses on Mount Sinai. It falls in May or June, on the sixth day of the Hebrew month of Sivan. Orthodox and Conservative Jews outside Israel observe Shavuot for two days. The holiday is also called Feast of Weeks because it comes seven weeks, or "a week of weeks," after the first day of Passover (see **Passover**).

The ancient Hebrews celebrated Shavuot as a harvest festival. They made pilgrimages to Jerusalem to offer sacrifices at the Temple. During the festival today, Jews read the Book of Ruth from the Bible. The book is set during the spring harvest. B. Barry Levy

Shaw, Anna Howard (1847-1919), was an American leader in the campaign for women's rights. She lectured throughout the United States calling for *woman suffrage* (voting rights for women). She also urged audiences not to drink alcoholic beverages.

Shaw was born in Newcastle upon Tyne, England. She came to the United States with her family when she was 4 years old. She spent much of her childhood on a homestead near Big Rapids, Michigan. Shaw was ordained a Methodist minister in 1880 and got an M.D. degree from Boston University in 1886. Few women of the 1800's entered either the ministry or medicine.

As a minister and a physician, Shaw became increasingly aware of the problems of women. She began to work with the American women's rights leader Susan B. Anthony in 1888 and lectured extensively in support of a woman suffrage amendment to the Constitution of the United States. Shaw served as president of the National American Woman Suffrage Association from 1904 to 1915. June Sochen

Shaw, George Bernard (1856-1950), an Irish-born playwright, critic, and essayist, became one of the most famous writers of the 1900's. Shaw was awarded the Nobel Prize for literature in 1925. He wrote over 50 plays in a remarkable career that spanned 70 years. His plays are performed more than those of any English-language playwright except William Shakespeare.

Shaw's dramas are filled with wit, challenging ideas, forceful characters, and vigorous, eloquent dialogue. While the plays often treat serious matters and promote Shaw's views, their points are frequently twisted, compromised, or emphasized through comedy. Shaw thought that a sense of humor can give balance and depth to seriousness.

Shaw also gained fame as a witty and wise "character." The press eagerly sought him out. Shaw was a political, social, and religious thinker. He was a critic of art, music, and theater, as well as a socialist, vegetarian, and feminist. Shaw had so many stimulating opinions and presented them so sharply that his views are often quoted. He defended his ideas in a series of essays, many published as prefaces to his plays. Like the plays, the essays are stimulating for their brilliance and wit, even when the causes they argue no longer seem daring or unconventional.

Early life. Shaw was born on July 26, 1856, in Dublin. In 1876, he settled in London. He wrote five novels, but none were successful. In 1884, Shaw joined the Fabian Society, an organization of socialists who believed that political and economic change could be gained through reform. Soon he represented the society in essays and lectures, and became known as one of England's finest public speakers (see **Fabian Society**). Shaw wrote music reviews from 1888 to 1894 and theater criticism from 1895 to 1898. He proved himself the keenest critic in London and among the best of any time.

Shaw promoted the realistic social dramas of Norwegian playwright Henrik Ibsen in a long essay, *The Quintessence of Ibsenism* (1891). The radical subject matter of two early plays showed Ibsen's influence. *Widowers' Houses* (1892) attacks slum landlords. *Mrs. Warren's Profession,* written in 1893, highlights the social causes of prostitution. It was immediately censored and not produced until 1902. Because of the unpopularity of these plays, Shaw then combined his unconventional views with more pleasant, often comic ingredients in *Arms and the Man* (1894), *Candida* (1897), *The Devil's Disciple* (1897), and *Caesar and Cleopatra* (1901).

Mature period. Shaw's plays were little known in England until many were performed at the Royal Court Theatre from 1904 to 1907. *Man and Superman* (1905) presents Shaw's theory of God as a "life force" evolving through humanity. In *Major Barbara* (1905), the ideals of the Salvation Army are challenged by the social philosophy of an armaments tycoon.

Shaw's popular *Pygmalion* (1913) was adapted into the musical *My Fair Lady* in 1956. In this ironic Cinderella story, a professor of *phonetics* (speech sounds) demonstrates the absurdity of class distinctions by teaching an ignorant Cockney girl how to speak and act like a duchess (see **Pygmalion**). *Heartbreak House* (1920) depicts the negligent society that allowed World War I (1914-1918) to occur. *Saint Joan* (1923) is a humanistic portrayal of the sainthood of Joan of Arc.

Shaw's later plays became increasingly political and fanciful. He also wrote an important book on socialism, *The Intelligent Woman's Guide to Socialism and Capitalism* (1928) and a religious parable called *The Adventures of the Black Girl in Her Search for God* (1933).

Charles A. Berst

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Shaw, Henry Wheeler. See **Billings, Josh.**

Shaw, Irwin (1913-1984), was an American novelist, short-story writer, and dramatist. Many of his works involve political issues. Shaw portrayed life in the United States as a struggle against the moral sickness he saw in modern American society. Shaw's works also reflect his ability to describe American character types.

Shaw's first novel, *The Young Lions* (1948), deals with the historical significance and horror of World War II (1939-1945). Many critics still recognize this novel as his best work. Two related novels, *Rich Man, Poor Man* (1970) and *Beggarman, Thief* (1977), are set against a background of social and political events from the mid-1940's to the late 1960's. *Nightwork* (1975) is Shaw's only comic novel. His other novels include *Two Weeks in Another Town* (1960); *Evening in Byzantium* (1973); *Bread Upon the Waters* (1981); and *Acceptable Losses* (1982). Many of Shaw's short stories appear in *Short Stories: Five Decades* (1978). He also wrote a number of screenplays.

Shaw was born on Feb. 27, 1913, in New York City. He first gained recognition with his antiwar play *Bury the Dead* (1936), in which dead soldiers refuse to submit to being forgotten by the living. Victor A. Kramer

Shawn, Ted (1891-1972), was a pioneer in establishing the role of the male dancer in America. Shawn developed his own method for training male dancers. He also created dances for men based on American Indian and Western folklore and on modern themes.

Edwin M. Shawn was born on Oct. 21, 1891, in Kansas City, Missouri. In 1915, he and his wife, Ruth St. Denis, formed the Denishawn dance company. He trained dancers and toured with her and the company until 1931 (see **Saint Denis, Ruth**). From 1933 until 1940, Shawn headed his own performing group of male dancers. He created and starred in several ballets, including *Invocation to the Thunderbird, Gnossienne,* and *St. Francis.* In 1941, Shawn established a summer dance school and festival at Jacob's Pillow, in Lee, Massachusetts. The festival has provided a showcase for established dancers as well as for young dancers and foreign companies.

Katy Matheson

Shawnee Indians lived in the eastern and midwestern United States. They spoke an Algonquian language and were closely related to the Sauk, Fox, and Kickapoo Indians.

The Shawnee first came into contact with white people during the late 1600's. At that time, they were living mainly in what are now Ohio, Tennessee, and North Carolina. In the early 1700's, many Shawnee moved to eastern Pennsylvania. But almost all of the Shawnee moved to what is now southern Ohio, along the Ohio River. Conflict then arose between the Shawnee and

white settlers for possession of the Indians' hunting lands. During the last half of the 1700's, the Shawnee played a central role in Indian opposition to colonial settlement west of the Appalachian Mountains. In 1774, colonial troops from Virginia defeated the Shawnee—who were led by their chief, Cornstalk—in a battle at what is now Point Pleasant, West Virginia.

After the battle, many Shawnee moved west across the Mississippi River. Those who stayed behind included Chief Tecumseh and his brother Tenskwatawa, known as the Shawnee Prophet. They united some Indian tribes into a single force and tried to halt the westward movement of white settlers. But the united forces broke apart after the Indians suffered heavy losses in the Battle of Tippecanoe in 1811. George J. Captain

See also **Cornstalk; Indian wars** (Along the frontier); **Kansas** (Communication); **Shawnee Prophet; Tecumseh.**

Shawnee Prophet (1775?-1837?) was a Shawnee Indian religious leader. He and the Shawnee chief Tecumseh, who were brothers, united Indians from many tribes to defend their land against whites.

The Shawnee Prophet was called Laulewasika during his early life. As a young man, Laulewasika suffered from alcoholism. Then, about 1805, he had visions that persuaded him to stop drinking and begin preaching. He changed his name to Tenskwatawa, which means *the open door.* He urged Indians to give up liquor and return to their traditional ways of life. Whites named him the Shawnee Prophet because they thought he predicted events. The Prophet lost most of his followers after he was defeated in the Battle of Tippecanoe in 1811.

Michael D. Green

See also **Indian wars** (Other Midwestern conflicts).

Shays, Daniel. See **Shays's Rebellion.**

Shays's Rebellion was a revolt by debtor farmers and their families in Massachusetts in 1786 and 1787. Many of the farmers faced imprisonment or loss of their property because they could not pay their debts. The rebels also protested taxes and court fees imposed by the state. The revolt was part of widespread discontent among small property owners and farmers after the Revolutionary War in America ended in 1783.

Shays's Rebellion was named for Daniel Shays, a leader of the revolt. Shays had served in the Revolutionary War, and after 1780 he held political offices in Pelham, Massachusetts. Shays's sympathy for his fellow farmers led him to take part in their protests. In August 1786, the unrest began to grow into revolt. Late that year, armed groups forcibly closed courts in Concord, Great Barrington, Springfield, Worcester, and other towns. In January 1787, an army led by Shays marched on the United States arsenal at Springfield but was forced to retreat. It was defeated decisively in February by Massachusetts troops under General Benjamin Lincoln. Scattered raids by the rebels continued until June.

In May 1787, John Hancock was elected governor of Massachusetts. Under Hancock, the state legislature pardoned nearly all the rebels. It also enacted laws to reduce court fees and provide some relief for debtors.

Fears aroused nationally by Shays's Rebellion intensified support for strengthening the federal government, and thus helped lead to the replacement of the Articles of Confederation, the nation's basic law, with the Constitution of the United States. In Massachusetts, however, disapproval of the treatment of the rebels and their sympathizers nearly prevented ratification of the Constitution by that state. Richard D. Brown

Shears. See **Scissors.**

Shearwater is the name of a group of sea birds that live in the oceans. They vary in length from 10 to 20 inches (25 to 51 centimeters). Shearwaters are brown or grayish-black. Some species have white bellies. Shearwaters have short, hooked bills, with tube-shaped nostrils. These birds soar over the waves, flapping their long, slender wings only occasionally. Some fly alone, but others gather in flocks that may include thousands. They eat fish, squids, and small crustaceans.

Shearwaters come to shore only to reproduce, usually on an island. The female lays one large white egg in a hole dug in the ground, or in a concealed spot under rocks. There are many species of shearwaters. One of the best known is the *great shearwater,* which lives in the Atlantic Ocean from near the Arctic Circle to southern South America and South Africa. Other shearwater species that live in North American waters include the *Manx shearwater,* the *pink-footed shearwater,* the *Buller's shearwater,* and the *sooty shearwater.*

James J. Dinsmore

Scientific classification. Shearwaters belong to the family Procellariidae. The scientific name for the great shearwater is *Puffinus gravis;* the Manx is *P. puffinus;* the pink-footed is *P. creatopus;* the Buller's is *P. bulleri;* and the sooty is *P. griseus.*

Sheeler, Charles (1883-1965), was an American painter and photographer. He is best known for paintings that blend realism with the geometric forms associated with Cubism. This style can best be seen in his paintings of interior and exterior architectural forms.

Sheeler was born on July 16, 1883, in Philadelphia. After a conventional art training, he moved toward more modern elements in his paintings, especially after his work was included in the Armory Show of modern art in 1913. In spite of the appearance of Cubist patterns in his work, Sheeler rarely omitted recognizable subject matter altogether. Instead, he applied Cubism's clear forms to distinctly American subjects, such as the simple barns of his native Pennsylvania and the factories of Detroit. He invented a style of precise and intense realism by which he is best remembered. His work in photography, with its literal realism, inspired his painting.

Charles C. Eldredge

Sheen, Fulton John (1895-1979), became one of the best-known spokesmen for the teachings of the Roman Catholic Church in the world. His more than 50 books, along with his articles, brought Catholic doctrine to millions of people around the world.

In 1950, Sheen resigned as professor at the Catholic University of America to direct the Society for the Propagation of the Faith in the United States. The society is an international mission aid agency that raises and distributes money for the support of Roman Catholic missionaries throughout the world. In 1966, Sheen was named the bishop of the diocese of Rochester, New York, by Pope Paul VI. He resigned from that position in 1969.

Sheen was a vigorous opponent of Communism in his writings and in his radio talks on "The Catholic Hour," a national program begun in 1930. During the 1950's, he became widely known as a television personality for his "Life Is Worth Living" series.

Sheen was born in El Paso, Illinois, and attended St. Viator College and St. Paul Seminary. After his ordination in 1919, he studied philosophy at the Catholic University of Louvain in Belgium. In 1926, he began teaching at the Catholic University of America. That year, Sheen also published his first book, *God and Intelligence in Modern Philosophy.* Richard J. Hauser

Sheep are among the most important animals that people have tamed because they provide both food and clothing. Long before people began to write history, shepherds watched the flocks of sheep in the fields to guard them against attack by wild animals. Today, sheep are raised in all parts of the world. China ranks as the world's leading sheep-producing country, and Australia ranks second. Other important sheep-raising countries include India, Iran, New Zealand, and Russia.

Sheep yield wool, meat, milk, and leather. They also furnish raw materials for such by-products as glue, soap, fertilizer, cosmetics, and the catgut used in stringing tennis rackets. Moreover, sheep eat plants in areas that people cannot safely farm. Thus sheep enable people to raise food, wool, and other products on land that would otherwise be useless for human agriculture.

The body of the sheep

Domestic sheep vary greatly in size. The *ewes* (females) of some breeds may weigh less than 100 pounds (45 kilograms), while the ewes of other breeds may weigh over 225 pounds (100 kilograms). *Rams* (males) are larger. Their weight, including a heavy coat of wool, ranges from 150 to 350 pounds (70 to 160 kilograms). Lambs weigh 3 to 13 pounds (1.4 to 6 kilograms) at birth.

Sheep are different from goats in many ways. They do not have the beard of the billy goat, nor the goat's odor. Sheep have a gland between their toes not found in goats. The horns of a ram usually curve outward. In some breeds, both rams and ewes have horns. In other kinds, only rams have horns, or the breed is hornless.

Sheep walk upon hoofs divided into two toes. The ankles of sheep are slim. But the upper part of their legs is muscular, helping them to move quickly and easily.

Sheep have no *incisor,* or cutting, teeth on their upper jaws, though they have eight on their lower jaws. They have six grinding teeth on the back part of each jaw. Sheep can bite off grass much closer to the ground than cattle can. In fact, where too many sheep are allowed to graze, plant life may become severely damaged. Most domestic sheep have tails, but these are cut off for reasons of cleanliness.

Sheep live for an average of 7 years, but some live as long as 13. Most ewes give birth to one or two lambs at a time. The mother's pregnancy lasts about five months. Ewes can begin breeding as early as six months of age, but most producers do not allow them to do so until they are about 1 $\frac{1}{2}$ years old.

Wild sheep

Sheep may have come originally from the plateaus and mountains of central Asia. The largest wild sheep, the *argali,* lives in the Altai Mountains of Siberia and Mongolia. The male argali stands 4 feet (1.2 meters) high at the shoulders. His spiral horns are 20 inches (50 centimeters) around.

The great Marco Polo sheep of Asia live in the Pamir mountains, the "roof of the world," 3 miles (5 kilometers) above sea level. Italian explorer Marco Polo first described this sheep in the 1200's. The Marco Polo sheep is a little smaller than the argali, but it is remarkable for the wide spread of its horns. The *blue sheep,* or *bharal,* which is closely related to the goat, lives in Tibet. About half a dozen other kinds of wild sheep live in Asia.

Wild sheep look somewhat like wild goats. They are high-spirited, daring, and self-reliant. They brave the fiercest storms of winter and climb higher than any other animals but mountain goats. Both wild and domestic sheep can consume plant foods that many other animals

John Moss, Colorific

Cheviot and Leicester crossbreed

Sheep provide clothing and food for people. The warm, fleecy hair that covers the bodies of domestic sheep is made into comfortable wool cloth. Many people enjoy the strong taste of mutton or the milder taste of tender lamb. People in nearly every part of the world raise sheep.

E. S. Ross

Karakul

Lia Munson

Suffolk and Corriedale crossbreed

Tony Carr, Colorific

Colbred

G. R. Roberts

Romney

cannot consume. Wild sheep live in bands among the mountains and plateaus of the Northern Hemisphere.

All the domestic breeds of sheep are descended from two different kinds of wild sheep. These are the *urial* from southern Asia, and the *mouflon,* the only kind of wild sheep still living in southern Europe. Both kinds of wild sheep probably resemble their original ancestors. Many kinds of bighorn sheep live in North America.

Breeds of domestic sheep

Domestic sheep have been slowly and carefully changed from their wild ancestors. Originally, wild sheep were tamed for the sake of their hides and milk. They were also used to carry burdens. However, sheep soon became more important to people for their fleece. The coarse hair that covered wild sheep was replaced by a soft coat of wool through breeding. Only in the last 200 years have breeders developed the animals primarily for their meat. People often divide sheep meat into two basic types: *mutton,* the meat produced by adult sheep, and *lamb,* the meat produced by lambs.

Today, there are more than 800 breeds and varieties of domestic sheep throughout the world. There are five main groups of sheep, depending on their fleece. They are *fine wool, long wool, crossbred wool, medium wool,* and *coarse wool.*

Fine-wooled sheep. Most fine-wooled sheep originated from the Spanish Merino breed. Spanish Merino sheep were developed in Spain. Their ancestors were probably brought to Spain by the ancient Romans. After the A.D. 700's, Spanish Merino sheep became greatly prized. Until the late 1700's, the Spanish government forbade taking them out of the country, but many were smuggled into Germany and France. It was in these countries that people developed the Merino into the modern type of sheep.

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The mouflon is a wild sheep from southern Europe.

There are more sheep with Merino blood than any other breed. *American Merino* sheep have white faces and legs, with thick coverings of fine wool down to their toes and noses. Rams usually have horns.

The *Rambouillet* is another important breed that is descended from the Spanish Merino. This hardy sheep first appeared in the 1800's. It is named after a town in France, but it was largely developed in Germany and, later, in the United States. The *Debouillet* breed, formed by crossing the Merino and the Rambouillet, was developed in New Mexico about 1920. People bred the Debouillet to produce wool and mutton under difficult range conditions.

Long-wooled sheep. Four of the most important long-wooled breeds come from England. They are the *Lincoln, Leicester, Cotswold,* and *Romney.* Lincoln sheep rank among the largest domestic sheep, and produce the longest fleece. The Leicester sheep is especially valuable to stock breeders for crossing with other sheep. It is the ancestor of most of the other long-wooled breeds. Ranchers have also used the Cotswold for crossbreeding. They often cross Cotswold rams with Merino ewes. Romney sheep originated in southeastern England and are popular in New Zealand, the northwestern United States, and other damp areas. Their bodies resist foot rot and parasite infections, common problems for other sheep in these conditions.

Crossbred-wooled sheep. People have developed many modern types of sheep by crossing two or more of the accepted domestic breeds. Except for the Merino and Rambouillet types, probably all modern breeds developed from such crossing. The *Corriedale* is a crossbred sheep that has become popular throughout Australia, New Zealand, South America, and North America. In the Corriedale, breeders developed a kind of *dual-purpose sheep* which can produce large amounts of both wool and mutton. The Corriedale was developed from fine-wool and long-wool sheep in Australia and New Zealand. The breed was first imported into the United States in 1914. Similar crosses have helped create other breeds, such as the *Colbred, Columbia, Montadale, Panama, Polwarth, Polypay, Romeldale,* and *Targhee.*

Medium-wooled sheep. These sheep are grown primarily for the meat they produce. They also provide a source of wool. The most important breeds are the *Hampshire, Shropshire, Southdown,* and *Suffolk.* Most farmers raise these sheep as purebreds. In western North America, people use them for breeding with white-faced range ewes of the Rambouillet, Columbia, Targhee, and other breeds. Such crosses produce black-faced *market lambs* sold for meat.

All four major breeds of medium-wooled sheep are popular on farms. These breeds originated in England. The face, ears, and legs of the Hampshire range in color from dark brown to black. The black face, ears, and legs of the Suffolk contrast sharply with its white wool body. The Southdown is a small sheep with a square-shaped body. The *Dorset* sheep produces lambs earlier in the year than do other breeds, thus providing lambs for the winter market. Other medium-wool breeds include the *Cheviot, Clun Forest, Oxford,* and *Tunis.*

Coarse-wooled sheep. *Karakul* lambs have a glossy fur used to make fur coats. Lambs usually are killed and pelted when they are 3 to 10 days old, when the fur is most valuable. The *Scottish Blackface,* also called the *Blackface Highland,* produces a wool used in tweeds, carpets, and mattresses. *Navajo* sheep produce a coarse wool for rugs and blankets.

Other types. Some sheep are not classified within the five main groups. For example, *hair sheep* have coarse hair rather than wool. Most hair sheep, such as the *Djallonka* breed, live in Africa.

Some sheep have been developed for milk produc-

Leading sheep-raising countries

Figures are for 1999.
Source: Food and Agriculture Organization of the United Nations.

Leading sheep-raising states and provinces

Figures are for Jan. 1, 1999.
Sources: U.S. Department of Agriculture; Statistics Canada.

tion. *East Friesian* dairy sheep are raised in Germany. Milk from *Roquefort* sheep is used to make Roquefort cheese in France. Sheep's milk differs in composition from cow's milk. It contains more protein than cow's milk and has a higher fat content.

People have also bred sheep to produce larger litters of lambs. Ewes of the *Finnsheep* breed, for example, average three lambs in a litter, and some have produced as many as eight living lambs at a time.

Raising sheep

Throughout history, farmers generally have raised sheep far from cities and other thickly populated areas. There are two main reasons for this practice. Compared to most products, wool is very valuable in proportion to its bulk. Furthermore, it does not spoil. Therefore, wool can be stored and shipped over long distances. In the second place, sheep tend to herd together, and therefore they can be handled in large bands in open country with very little labor. Sheep like to eat grasses and shrubs. They can live without water for long periods of time. Thus, farmers can raise sheep on dry plains.

People raise sheep in two distinctly different ways. The most important way occurs on the range. Here sheep are herded in large bands containing from 1,000 to 2,000 or more sheep. The herds are moved about on large tracts of land that may be owned by the sheep owner, or may be leased from another owner or from the government. The sheep primarily eat range grasses.

The other important way of raising sheep occurs on farms. The farmer raises from thirty to a few hundred sheep, keeping them in fenced pastures. In winter, the sheep eat grain and hay grown on the farm.

Enemies of sheep

Sheep are attacked by various parasites and diseases. Foot rot and sore mouth are common diseases. Sheep suffer from internal parasites, and also from a disease called *sheep scab* caused by mites and ticks. Meat-eating wild animals often attack sheep, and dogs sometimes kill sheep. Coyotes kill at least 4 percent of all lambs born in the United States each year. The kea parrot of New Zealand sinks its sharp, hooked bill into the sheep's back, causing puncture wounds that can turn into open sores. Melinda J. Burrill

Scientific classification. Sheep belong to the bovid family, Bovidae. The urial sheep is *Ovis vignei*. The mouflon sheep is *O. musimon*. Domesticated sheep are *O. aries*.

Related articles in *World Book* include:

Animal (pictures: Animals of the mountains)	Lanolin
Australia (Agriculture; pictures)	Livestock
Bighorn	Mange
Bot fly	Mutton
Foot-and-mouth disease	Prion
Karakul	Ranching
Lamb	Ruminant
	Wool

Additional resources

Ensminger, M. E. *Sheep and Goat Science*. 6th ed. Interstate, 2002.

Parker, Ronald B. *The Sheep Book*. Rev. ed. Swallow, 2001.

Simmons, Paula, and Salsbury, D. L. *Your Sheep: A Kid's Guide to Raising and Showing*. Garden Way, 1992. Younger readers.

Sheepdog is any of a number of breeds of dogs that people use to herd other animals. Sheepdogs return wandering animals to the herd and keep the herd together. Sheepdogs also defend the herd from attacks by wolves and other animals. In the past, the word *sheepdog* described dogs that were bred to herd only sheep. Today, the word is also used for dogs that herd other animals, including geese, ducks, cattle, and even reindeer. Sheepdogs are loyal, gentle, and intelligent animals. Reviewed by the American Kennel Club

Related articles in *World Book* include:

Australian cattle dog	Dog (picture: Herding dogs)
Australian shepherd	German shepherd dog
Bearded collie	Old English sheepdog
Belgian sheepdog	Pembroke Welsh corgi
Cardigan Welsh corgi	Polish lowland sheepdog
Collie	Shetland sheepdog

Sheffield (pop. 500,500; met. area pop. 1,249,300) is an industrial city in north-central England. It lies in a scenic, hilly area where the River Don and River Sheaf meet (see England [political map]). An important manufacturing city, Sheffield has long been a center for the production of high-grade steel, silver plate, and metal products. Its cutting tools and *cutlery*—silverware, teapots, and other table utensils—are internationally famous.

An Anglo-Saxon agricultural settlement probably stood on the site of what is now Sheffield as early as the A.D. 1000's. Sheffield grew rapidly during the Industrial Revolution of the 1700's and 1800's, when it became England's main center for steel production. Until the mid-1900's, the city had large run-down areas, and German bombs had destroyed sections of it during World War II (1939-1945). But a major urban-renewal program, begun in the 1950's, wiped out most of this urban blight. Today, Sheffield has attractive public housing, modern commercial and industrial areas, and pleasant parks and other landscaped sites. G. Malcolm Lewis

Shehan, *SHEE uhn,* **Lawrence Joseph Cardinal** (1898-1984), was an American religious leader. He was named a cardinal of the Roman Catholic Church in 1965 by Pope Paul VI. He also received the honorary title of primate of the United States because his Baltimore diocese is the oldest in the country. Cardinal Shehan was ordained a priest in 1922, and served at St. Patrick's Church in Washington, D.C., from 1923 to 1941. He became a bishop in 1945 and was appointed first bishop of Bridgeport, Connecticut, in 1953. He served as archbishop of Baltimore from 1961 until he resigned in 1974. He was born on March 18, 1898, in Baltimore.

Robert P. Imbelli

Sheik, *sheek* or *shayk,* is an Arabic title referring either to an old and respected man or to the chief of a tribe or village. Sometimes a sheik is a religious leader. Only Muslims use the title of sheik. A sheik's power usually depends upon his own will and character. Songs and stories have pictured the sheik as a romantic figure.

Shekel, *SHEHK uhl,* is the monetary unit of Israel. The word *shekel* originally meant a unit of weight. The shekel was used as a weight by Babylonians, Phoenicians, and Hebrews. The Bible often refers to the Hebrew shekel. It weighed about 218 grains, or about $\frac{1}{2}$ ounce (14 grams). It was first used as money in the form of uncoined gold and silver. The Hebrews coined their first shekels about A.D. 66. Half and quarter silver shekels also were coined. R. G. Doty

Shell. See Ammunition.

Walter Dawn

Coiled shell of land snail

John H. Gerard

Brittle bird's egg shells

Peter Throckmorton from Nancy Palmer

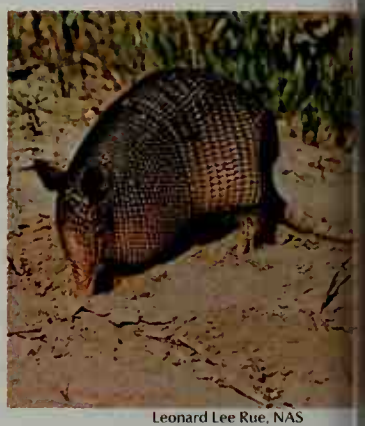
Leathery shell of sea turtle

Ben Cropp, Keystone

Huge shell of giant clam with crown-of-thorns starfish

Walter Dawn

Tough shell of stag beetle



Leonard Lee Rue, NAS

Plated shell of armadillo

Shell

Shell is an important feature of many animals and plants. Most shells grow on the outside of living things. These shells are like strong suits of armor that protect the organisms they cover. Clams, turtles, and coconut seeds have outside shells. In cuttlefish and many kinds of squid, the shells grow inside the bodies. Such shells, called *cuttlebones* in cuttlefish or *pens* in squids, help support the bodies of the animals.

Some kinds of shells have beautiful shapes and bright colors. Others are plain and colorless. Among the smallest kinds are the shells of vitrinellids, marine snails found in many parts of the world. Some vitrinellid shells grow only about as big as a grain of sand. The largest shell is that of the giant clam of the South Pacific and Indian oceans. Its shell can measure 4 feet (1.2 meters) long and weigh 500 pounds (230 kilograms).

Some kinds of animals begin their lives inside egg shells. Thin, brittle shells cover the eggs of birds. Thick, leathery shells protect the eggs of alligators, snakes, and many other reptiles. Strong, rubbery shells cover the eggs of the platypus and echidna. Many other animals spend all their lives in shells that are important parts of their bodies. The shells of clams and oysters are really the skeletons of these animals. The shells of turtles and tortoises include part of their backbone and ribs.

Many people collect shells as a hobby. Most shells in these collections belong to *mollusks,* a group of animals that includes clams, conchs, cowries, oysters, and snails. This article provides general information about mollusk shells. For information about the animals that grow these shells, see the separate *World Book* article on **Mollusk** and its list of *Related articles.* For information about other kinds of shells, see the *World Book* articles on **Egg** and **Seed**, and articles on individual plants and animals, such as **Walnut** and **Turtle**.

How shells are formed

There are about 100,000 living species of mollusks. Each kind has a shell with its own special design and shape, but all are formed in much the same way. Some mollusks that grow shells live in the ocean, some in fresh water, and others on land.

Robert S. Prezant, the contributor of this article, is Dean of the Division of Mathematics and Natural Sciences at Queens College of the City University of New York.

Many shells consist of three layers—an outer, middle, and inner layer. These layers are also called the *prismatic layer* (outer layer), the *lamellar layer* (middle layer), and the *nacreous layer* (inner layer). Many primitive mollusks have only two layers, a prismatic and a nacreous layer. Each layer contains mineral crystals and an organic mortar holding the crystals together. The crystals consist of calcium carbonate, a kind of lime also found in marble and some other kinds of rocks. The prismatic layer is composed of small, elongated particles called *prisms*. *Nacre* or *mother-of-pearl* often is deposited on the inner shell surface as small six-sided or cookie-shaped tablets. These grow and combine into a smooth, glossy sheet.

The food eaten by a mollusk, and the water or soil it lives in, provides the minerals that form the shell and give it color. The blood stream of the animal carries the minerals to the *mantle*, a fleshy skinlike tissue that produces the shell. The inner layer of the mantle forms the inner shell layer, and the outer edge of the mantle helps form the middle and outer shell layers. A part of the mantle also produces the *periostracum*, a thin layer that covers the outer shell. Thinner periostracums are clear while thicker ones are darker. In some species, the periostracum can form hairlike structures on the outside of the shell, giving the mollusk a shaggy appearance.

The pattern of the shell color depends on (1) whether color is added continuously, and (2) the number of places in the mantle from which color is added. For example, if color is added continuously from only one place in the mantle, the shell will have one stripe. If color is added continuously from four places, the shell will have four stripes. If the color flow is interrupted from time to time, spots or bars will form on the shell.

Most kinds of mollusks add material to their shells throughout their lives. As long as the animal grows, its shell also grows. Clams and snails begin to grow shells before they hatch. After they leave the egg, their bodies rapidly increase in size. A sea snail that is only $\frac{1}{10}$ inch (3 millimeters) long when it hatches may grow 5 or 6 inches (13 or 15 centimeters) in six months. Most clams and sea snails grow for about six years, though some may reach 100 years of age.

Kinds of mollusk shells

Mollusk shells can be divided into five main groups, each with a common name and a scientific name. These groups are (1) gastropods *(GAS truh pahdz)*, also known by the scientific name Gastropoda *(gah STRAHP uh duh)*, (2) bivalves or Bivalvia *(by VAL vee uh)*, (3) tooth shells or Scaphopoda *(skah FAHP uh duh)*, (4) octopuses and squids, or Cephalopoda *(sehf uh LAHP uh duh)*, and (5) chitons *(KY tuhnz)* or Polyplacophora *(pah lee pluh KAHF uh ruh)*. A sixth group of mollusk shells, the Monoplacophora *(mahn oh pluh KAHF uh ruh)*, is rarely seen. Scientists have found these shells only as fossils or in the deepest ocean waters.

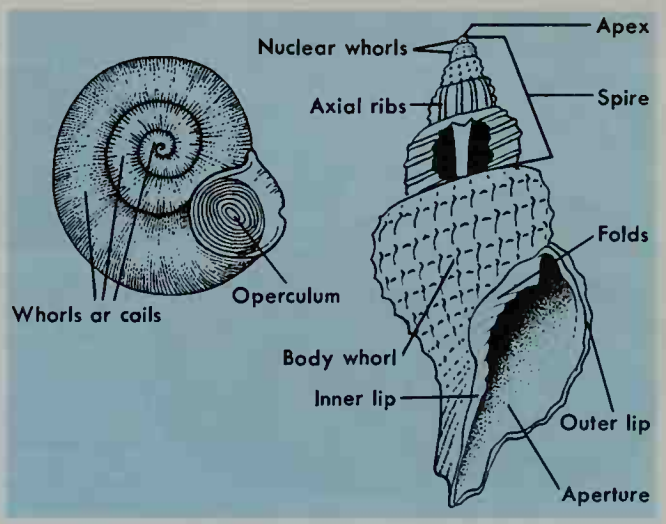
Gastropods have a single shell made up of one plate or *valve*. These mollusks are sometimes called *univalves*, which means *one shell*. Snails are an important group of gastropods. A majority of snails have a tubelike shell that winds around itself as it grows. The soft body of the snail is in the spiraling tube. Most snail shells grow by winding to the right in a clockwise direction when viewed from above, and are called *right-handed shells*. A few species of snails possess *left-handed shells*.

The shells of gastropods have an opening at one end. Most of them have a hard lidlike part called an *operculum* at the opening. The animal can pull the operculum over the entrance of the shell to keep out small predators such as fish and crabs.

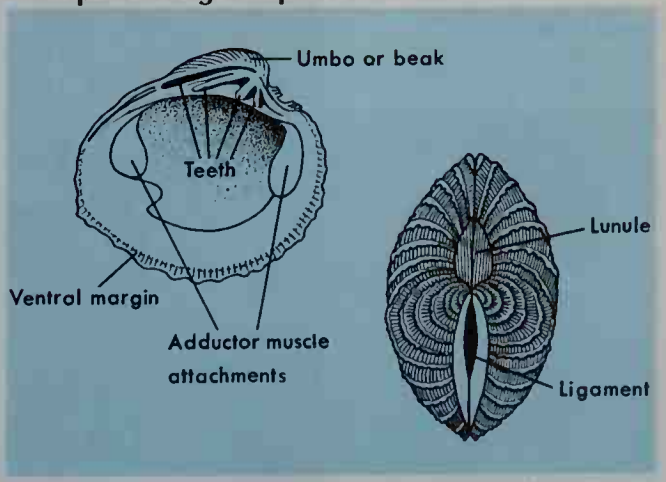
Gastropods are found in almost every part of the world except on the highest mountain peaks. Some live in the ocean, some in fresh water, and some on land. Many ocean snails have smooth, glossy shells. Others possess shells with deep ridges, rough surfaces, and long, sharp spines. The carrier shell snail attaches bits of shells, stones, and other objects to its shell as it grows. The newly deposited shell substance acts as cement, and when the shell hardens, the objects are held firmly in place. Most snails that live in fresh water or on land have thin, smooth shells. Many tree snails, particularly those of the tropics, have brightly colored shells.

Limpets are also gastropods. Their shells grow almost flat and form a point in the center. The shells of keyhole limpets have a hole at the top, and look like miniature volcanoes.

There are more than 80,000 species of snails. The largest species are the horse conch of Florida and the baler of Australia. Both of these species grow about 2 feet (61 centimeters) long. A giant African snail has a



The parts of a gastropod shell



WORLD BOOK illustrations by Tom Dulan

The parts of a bivalve shell

Commercial top shell
Trochus niloticus
Indian and S.W. Pacific oceans
$\frac{1}{3}$ actual size

Delphinula shell
Angaria delphinus
S.W. Pacific Ocean
Actual size

Oriente tree snail
Polymita picta
Cuba
Actual size

Eastern moon snail
Polinices duplicatus
U.S. Atlantic Coast
$\frac{1}{2}$ actual size

Limpet
Patella lugubris
Azores
$\frac{1}{3}$ actual size

Carrier shell
Xenophora neozelanica
New Zealand Coast
$\frac{1}{2}$ actual size

Left-handed whelk
Busycon contrarium
U.S. Atlantic Coast
$\frac{1}{2}$ actual size

(top)

Tiger cowrie
Cypraea tigris
Indian and S.W. Pacific oceans
$\frac{1}{2}$ actual size

(underside)

Tent olive shell
Oliva porphyria
Pacific Coast of Panama
$\frac{1}{2}$ actual size

Regal murex
Murex regius
Pacific Coast, Mexico to Panama
$\frac{1}{2}$ actual size

Textile cone
Conus textile
Indian and S.W. Pacific oceans
$\frac{1}{3}$ actual size

Crown conch
Melongena corona
West Florida Coast
Actual size

Bivalve shells

Fragile river mussel
Leptodea fragilis
Fox River, Illinois
$\frac{1}{2}$ actual size

Pacific thorny oyster
Spondylus pictorum
Pacific Coast of Mexico
$\frac{1}{4}$ actual size

Mantle scallop
Gloripallium pallium
S.W. Pacific Ocean
$\frac{1}{2}$ actual size

Sunrise tellin
Tellina radiata
West Indies
$\frac{2}{3}$ actual size

Blue mussel
Mytilus edulis
North Atlantic Ocean
$\frac{1}{2}$ actual size

Royal comb Venus
Pitar dione
Caribbean Sea
$\frac{2}{3}$ actual size

Nautilus shell

(whole)

Chambered nautilus
Nautilus pompilius
S.W. Pacific Ocean
$\frac{1}{4}$ actual size

(cutaway)

Chiton shell

West Indian chiton
Chiton tuberculata
West Indies
$\frac{2}{3}$ actual size

Tooth shell

Elephant's tusk shell
Dentalium elephantinum
Japan and Philippine Islands
Actual size

WORLD BOOK photos; specimens courtesy the Academy of Natural Sciences of Philadelphia and Albert Lindar.

larger shell than any other land snail. It is about 8 inches (20 centimeters) long. Many gastropods have shells so small they can hardly be seen with the unaided eye. A row of 30 Barleeia snail shells is less than 1 inch (2.5 centimeters) long.

Bivalves have two matching valves. The valves move on hinges that look like small teeth. Clams, oysters, and scallops are bivalves. Bivalves keep their shells open while they are eating or breathing and when they are undisturbed. A broad band of elastic tissue acts like a prop to hold the valves apart. Bivalves also have one or two strong *adductor* muscles attached to both valves. If a predator comes near, these muscles snap the shell shut and keep it closed. If the muscles get tired and relax, the shell opens again. A predator usually does not wait this long.

Bivalves are found almost everywhere except on dry land. There are about 11,000 kinds of bivalves. Most of them live in shallow ocean waters near land and in lakes, but a few species live in beds in large rivers. Among the best known of these are the freshwater clams of the Mississippi River Valley. Occasionally, a pearl is found in these shells. But most pearls valued as gems come from ocean-dwelling pearl oysters.

The giant clam of the South Pacific, whose shell can grow 4 feet (1.2 meters) long, is the largest bivalve. The smallest include turton clams of the North Atlantic. They grow about half as large as a grain of rice.

Tooth shells look like long needles or like miniature elephant tusks. They are sometimes called *tusk shells.* The shells are hollow tubes that curve slightly and become smaller at one end. Both ends are open.

Tooth shells are found in the sand or mud of the ocean bottom in many parts of the world. Some kinds live close to shore. Others burrow in the ocean floor far below the surface of the water. The small end of the shell sticks up into the water.

Scientists recognize about 500 kinds of tooth shells. The shells vary from $\frac{1}{2}$ to 5 inches (1.3 to 13 centimeters). Most are white, but some have green, red, or yellow tints. The most colorful kind is an elephant's tusk from the Philippines. It is dark green with bluish ribs.

Octopuses and squids. In this group of marine animals, the cuttlefish and squids have shells inside their bodies. The cuttlefish, also called the Sepia squid, has a chalky cuttlebone inside its body. This shell is light and spongy, but it serves as a strong support for the animal's body. The Spirula squid has a shell about 1 inch (2.5 centimeters) long under the skin at the rear of its body. The coiled Spirula shell looks somewhat like a ram's horn. In tropical countries, waves often wash these coiled shells ashore. Octopuses have no shells.

Perhaps the best-known shell of this group is the chambered nautilus, or pearly nautilus. It consists of a series of chambers, each larger than the one before. Its soft body is found in the outermost chamber. Thin walls seal off the other chambers. However, they are connected by a narrow tube that enables nitrogen and other gases to enter and leave the chambers. The coiled shell is cream colored with brown stripes, and the chambers are lined with shiny mother-of-pearl. Nautilus shells grow up to 10 inches (25 centimeters) in diameter. They live mostly in the western Pacific.

The paper nautilus or argonaut has a single, paper-thin shell much like that of the chambered nautilus, but with no chambers. Only the female paper nautilus builds a shell. The female resides in the shell and stores her eggs there. The paper nautilus lives at the surface of warm tropical seas.

Chitons. A chiton shell consists of eight separate, movable pieces called *plates* that are held together by a surrounding leathery *girdle* (belt). The girdle acts like a series of hinges between the plates and enables the animal to bend and move about easily. The individual plates are usually hard, white, and shaped like a butterfly. Chiton shells are also called coat-of-mail shells because they look like tiny suits of armor. Chitons attach themselves to rocks in the sea. Some are less than 1 inch (2.5 centimeters) long. The largest chiton, Steller's chiton of the California coast, grows up to about 1 foot (30 centimeters) long.

Collecting shells

Many people find shell collecting a fascinating hobby. They spend leisure time hunting and cleaning shells, and mounting them in attractive displays. Some collectors become so interested in their hobby that they begin the scientific study of shells, which is called *conchology.* Hundreds of amateur and professional shell collectors exchange ideas, information, and shells through shell clubs in cities in almost every country.

Beginning collectors gather all the shells they can find, even broken and discolored ones. Serious collectors replace poor shells with those of the finest quality as soon as they can. The best quality shells are obtained from *live mollusks*—those taken with the animal still inside. These shells have their natural color and luster because they have not been bleached by the sun or worn down by sand or waves. However, people should be careful when they collect the living animals. Some cone snails of the Indian and southwest Pacific oceans have a poisonous sting. The next best quality are *recently dead shells.* Storm waves or outgoing tides leave them on the beach. The poorest shells are *dead shells.* Most shells found on beaches are dead shells. The sun has faded the colors, and sand and water have dulled the luster.

Searching for shells. You can find the best sea shells during the night or in the early morning hours at low tide. Use a strong flashlight or lantern to light your way. Wear a bathing suit and soft canvas shoes, and take a small bag or bucket to hold the shells. Look for clams buried in the sand, for snails sheltered under rocks, and for scallops hiding in eelgrass. However, you should put rocks, algae, and logs back in their original position once you are finished. Hunt for sea shells with a companion who can help in case of an accident.

Many kinds of freshwater mussels and snail shells are found in rivers, streams, lakes, ditches, and ponds. Use a dip net to sweep along the grassy edges of ponds. To find the shells of land snails, roll logs over, scrape away the leaves and soil, and look in the cracks of the bark.

As you gather shells, write down the date and the exact location where you find them. Keep these notes with the shells until you add them to your collection. Then put the information on labels that identify the shells.

Cleaning shells. The best and simplest way to clean live mollusk shells is to boil them. Put the shells in a pan of water, bring the water slowly to a boil, and boil for 5

to 10 minutes. Then let the water cool slowly. With luck, the soft tissue will fall out. Use a twisted safety pin to pull out any remaining soft tissue. Save the snail's operculum because it belongs with the shell. Wash the shells with soap and water, and place them on paper to dry in the sun. Very small live shells can be soaked in alcohol for several days, and then dried in the sun.

Displaying shells. You can mount your shells on cardboard, or you can put them on cotton in flat boxes with glass or plastic covers. Some collectors use a cabinet with large drawers to store their shells. A square cardboard tray holds each kind of shell. A label bears the name of the shell and tells where, when, and by whom it was collected. The label should describe the shell's surroundings, such as grass, mud, sand, or depth of water. A logbook serves as an index to the shells in the collection and gives further information about them.

Every part of a shell helps identify it. For example, the number and location of the teeth in a shell hinge show that the mollusk belongs to a certain family of clams. The color, ridges, and shape of a snail shell identify the group to which it belongs. Each part of a shell has a special name, such as lip, ribs, or shoulders. The drawings in this article show the parts of shells and name them.

A shell collection should be arranged so that it begins with the shells of the simplest kinds of mollusks. Many shells have popular names, such as mouse cone or Florida cone. These names can vary from one country to another, and even from one area to another. For this reason, collectors identify shells by their scientific names. These names are in Latin and are understood by collectors and biologists in all parts of the world. The Latin name of the mouse cone is *Conus mus,* and that of the Florida cone is *Conus floridanus.*

Conserving shells. Scientists believe that over-collecting of shells and pollution have caused some mollusks to become scarce. To help conserve mollusks, do not collect more shells than you need. One or two good specimens of a species should be enough for your collection. Avoid collecting freshwater mussels, many of which have become endangered. People who illegally collect endangered species face a stiff fine.

Uses of shells

In prehistoric times, cowrie and tooth shells were used as money. The Phoenicians and Romans made a

Preparing a shell collection

Most shell collectors like to find and prepare their own shells. They hunt for shells along the shores of oceans, lakes, or rivers. Then they clean the shells, identify and label them, and arrange them in attractive displays. Some collectors buy special shells for their collections.

Mike Mazzaschi, Stock, Boston

Boys collecting shells

WORLD BOOK photo by Steinkamp/Ballogg

Cleaning the shells

Identifying the day's find

WORLD BOOK photo by Steinkamp/Ballogg

Labeling the shells

WORLD BOOK photo by Steinkamp/Ballogg

An interesting shell display

Cary Wolinsky, Stock, Boston

Madonna of the Sea, courtesy of Edward Waldo Forbes Heirs

Shell mosaic, by Edward Waldo Forbes and associates, is made from pieces of clamshells fitted to form the design.

The Metropolitan Museum of Art, New York. Bequest of Benjamin Altman, 1913

A golden shell, *shown here,* forms the top of an elegantly designed jeweled cup known as the Rospigliosi Cup.

A butterfly pin, *shown here,* combines gleaming mother-of-pearl with silver to make the insect's colorful wings.

Walter Dawn

purple dye from murex sea snails. They believed that cloth colored with this dye was more valuable than gold. The Indians of North and South America also used shells as money. North American Indians carved wampum beads from large clam shells and parts of the knobbed whelk of the Atlantic Coast.

The color and luster of shells have made them especially useful as decorations and for jewelry. Before plastic became popular, manufacturers commonly cut the shells of freshwater mussels to make buttons. Today, craftworkers use mother-of-pearl from abalone and oyster shells to decorate fancy boxes, jewelry, and musical instruments. Artists carve raised designs called *cameos* in many kinds of shells to make jewelry. Conchs and some other large shells can be polished and used as lamp bases or paperweights. Craftworkers fasten many kinds of small shells together in the shape of animals or dolls, or to form attractive designs.

In the Philippines, the thin, almost transparent shells of the placuna oyster serve as window "glass." The shells are cut into small squares and put into narrow wooden frames. The frames are then fastened together to make a large window.

Scientists sometimes use shells to help them in their work. Shells drilled from the ocean floor provide clues to water temperatures in ancient times. Oil prospectors search for certain fossil shells in deserts and prairies. The shells show that the area was an ocean bed in ancient times. Large oil pools formed in many of these beds.

People also use shells in their diet. Oyster shells provide a good natural source of calcium. People can take tablets containing ground up oyster shells as a calcium supplement. Robert S. Prezant

Related articles. See Mollusk and its list of *Related articles.* See also the following articles:

Armadillo
Crustacean
Fossil
Mother-of-pearl
Pearl
Turtle
Wampum

Outline

I. How shells are formed
II. Kinds of mollusk shells
- A. Gastropods
- B. Bivalves
- C. Tooth shells
- D. Octopuses and squids
- E. Chitons

III. Collecting shells
- A. Searching for shells
- B. Cleaning shells
- C. Displaying shells
- D. Conserving shells

IV. Uses of shells

Questions

What is a gastropod shell?
When are the best times to hunt for sea shells?
What is the largest shell?
How many layers do most mollusk shells usually have?
What is *conchology*?
When do clams and snails begin to grow shells?
Where do mollusks get the minerals for their shells?
What do keyhole limpet shells look like?
Why are tooth shells sometimes called *tusk shells*?
How does the paper nautilus use its shell?

Additional resources

Level I

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Lember, Barbara H. *The Shell Book.* Houghton, 1997.

Level II
Hill, Leonard. *Shells: Treasures of the Sea.* Hugh Lauter Levin, 1996.
Vermeij, Geerat J. *A Natural History of Shells.* Princeton, 1993.
Wye, Kenneth. *Encyclopedia of Shells.* Facts on File, 1991.

Shell shock. See Post-traumatic stress disorder.

Shellac, *shuh LAK,* is the liquid formed of resin flakes which have been dissolved in alcohol. It is used as a varnish. The flakes are the dried form of a sticky substance called *lac resin* (see Lac). When shellac is applied to a surface, the alcohol in the solution evaporates, leaving a shiny finish. Shellac resin flakes are yellow, orange, or reddish, but can be bleached white. Shellac is also used in the manufacture of candies, drug tablets, and printing inks; in insulating materials; and as a stiffener. See also Lacquer; Resin; Varnish. Roger D. Barry

Shelley, Mary Wollstonecraft, *WUL stuhn KRAFT* (1797-1851), was an English author. Shelley wrote the famous Gothic horror novel *Frankenstein* (1818).

Shelley was born in London. Her family name was Godwin. Her father was the radical philosopher William Godwin, and her mother was Mary Wollstonecraft, an early feminist. When she was 16, Mary met the poet Percy Bysshe Shelley. Although Shelley was married, she ran away with him. They were married after Shelley's first wife died in 1816. That same year, Mary conceived the idea for *Frankenstein.*

Shelley drowned near Livorno (sometimes called Leghorn), Italy, in 1822. To support herself and her children, Mary wrote novels, including *Valperga* (1823), *The Last Man* (1826), and the autobiographical *Lodore* (1835). She also edited her husband's poetry. Mary spent much of her later life trying to seek her own identity in relation to those of her famous parents and husband.

Frederick W. Shilstone

See also Frankenstein; Gothic novel; Shelley, Percy Bysshe; Godwin, William; Wollstonecraft, Mary.

Shelley, Percy Bysshe, *bihsh* (1792-1822), was one of the great English lyric poets. He experimented with many literary styles and had a lasting influence on many later writers, particularly Robert Browning, Algernon Charles Swinburne, William Butler Yeats, George Bernard Shaw, and Thomas Hardy.

His life. Shelley was born on Aug. 4, 1792, in Sussex into a wealthy and politically prominent family. He had a stormy career at Eton College and Oxford University, from which he was expelled in 1811 for writing a pamphlet called *The Necessity of Atheism.*

In August 1811, Shelley eloped with 16-year-old Harriet Westbrook, the daughter of a former London coffee house owner. He abandoned her in 1814 and ran away with Mary Wollstonecraft Godwin. Mary was the daughter of William Godwin, a political philosopher whose liberal ideas greatly influenced Shelley. Although both said they did not believe in marriage, Shelley and Mary Godwin were married in 1816, after Harriet drowned herself. They had three children, two of whom died in infancy. See Shelley, Mary Wollstonecraft.

Shelley believed the Irish were being oppressed by their English rulers. He tried to rouse the Irish to rebel against England in his pamphlet *An Address to the Irish People* (1812). He wrote *Queen Mab* (1813), a revolutionary poem which attacked both political tyranny and orthodox Christianity. In 1816, Shelley and his wife became close friends with the poet Lord Byron in Geneva, Switzerland. That friendship led to an ongoing exchange of ideas that Shelley commemorated in *Julian and Maddalo* (1824), a poem in the form of a conversation.

Portrait by Amelia Curran; National Portrait Gallery, London
Percy Bysshe Shelley

After March 1818, Shelley went into exile in Italy. There he wrote a series of important works, including the play *The Cenci* (1820) and the poems *Prometheus Unbound* (1820), *The Witch of Atlas* (1820), *Epipsychidion* (1821), and *Hellas* (1822). The death of an acquaintance, the English poet John Keats, inspired his elegy *Adonais* (1821). On July 8, 1822, Shelley drowned while sailing near Livorno (sometimes called Leghorn), Italy.

His writings. Shelley's poems are emotionally direct but difficult to understand intellectually. Much of his poetry is openly autobiographical, including his most famous lyric "Ode to the West Wind" (1819). Shelley's spiritual attitudes were intensely personal and tended to oppose traditional Christian views. Shelley felt that spiritual truth was not based on either supernatural revelation or natural experience. Instead, he thought truth could be understood by the imagination alone. Shelley debated the role of the imagination as a spiritual guide in "Mont Blanc" (1816). This powerful meditative poem first revealed Shelley's mature style. Another early lyric, "Hymn to Intellectual Beauty" (1816), tells of Shelley's decision to devote his life to the pursuit of ideals. He also developed this theme in his poem *Alastor* (1816).

In his most ambitious long poem, the lyrical drama *Prometheus Unbound,* Shelley attempted to combine his imaginative faith with his hopes for humanity's redemption here on earth. Like much of Shelley's work, this play is based on classical Greek models. Prometheus, the creative power in humanity, is liberated by Demogorgon, a mythical figure who stands for inevitable change in human events. Prometheus forgives his tormentor, Jupiter, symbolizing the poem's insistence on the power of mercy, forgiveness, and selfless love. At the end of the play, tyrannical earthly rulers and corrupt governmental institutions are defeated and love and beauty reign, though perhaps not forever. Shelley examined the practical moral implications of these ideas in his realistic Elizabethan-style tragedy, *The Cenci.*

Shelley's later poetry became more somber and skeptical. The Irish poet William Butler Yeats described Shelley's theme as an increasing conflict between infinite desire and the inability fully to realize such desire. The autobiographical *Epipsychidion* records Shelley's vision of ideal love finding its lasting home in an earthly paradise. The poem describes his supposed success in achieving that vision through his love for an Italian noblewoman, Emilia Viviani. In the end, however, the poem casts doubt on that success and, even more, on the ability of mere words to describe such perfection.

In 1821, Shelley wrote his famous essay *A Defence of Poetry.* The work is valuable for its insights into poetry

and Shelley's attempt to use his views on imagination to define the role of poets. He asserts that poets sow the seeds of future reforms but do not themselves live to witness their realization.

Whether Shelley had begun to find some definite faith, philosophical or otherwise, we do not know, but his final poems are as grim and sorrowful as any he wrote. The last love lyrics that Shelley wrote are serene only in their hopelessness. According to his powerful unfinished poem on human defeat, *The Triumph of Life,* good and the means of accomplishing good cannot be reconciled. However grim his final vision, Shelley held on to the hope of inspiring future generations, as in the "Ode to the West Wind":

> Scatter, as from an unextinguished hearth
> Ashes and sparks, my words among mankind!
> Be through my lips to unawakened earth
> The trumpet of a prophecy! ...

Frederick W. Shilstone

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Shellfish. See Crustacean; Mollusk.

Shelter is a structure or a natural feature that provides protection against bad weather, danger, or insect pests. People need shelters to shield them from extremes of cold and heat, as well as from rain, snow, and wind.

There are many different kinds of shelters. Houses are the most common form. Other kinds of shelters are bus shelters, bomb shelters, sheds, and band shells. Portable shelters include tents, trailers, houseboats, and motor yachts.

The first shelters made by human beings were built of animal hides, stones, straw, vines, or wood. Today, people construct shelters from a wide variety of materials. Many home builders use wood and brick. Steel and concrete provide the framework for high-rise apartment buildings. Builders also use such materials as aluminum, glass, and plastic. This article deals with human shelter. Animals also build shelters, such as birds' nests and rabbit burrows. For information on animal shelters, see **Animal** (Animal homes).

Why shelters differ around the world

People build many different kinds of shelter throughout the world. The types of shelters they erect depend chiefly on the climate and on what building materials are available.

Climate. In hot areas, such as the southern and southwestern United States, the weather is warm enough for people to live outside much of the time. But they still need protection from sun, rain, and insects. Houses in such areas have many screened windows, doors, and other openings that let in breezes but keep out insect pests.

In the northern United States, Canada, and other cool regions, houses are designed to keep out the cold and keep in heat. Many buildings have thick walls and storm windows to minimize heat loss.

Hubertus Kanus, Shostal

Houses in Norway have steep, pointed roofs that allow snow to slide off easily during the winter. The roofs also must be strong enough to bear the weight of heavy snow.

Hutchison Library

Oriental houseboats provide shelter for many families. Many people live in boats for a lifetime, cooking their meals, eating them, and sleeping in the same small quarters.

In such northern cities as Toronto and Calgary, Canada, heated walkways connect apartment buildings to offices, shopping malls, theaters, and other facilities. Residents of these apartment buildings may go about their everyday activities during the winter months without going outside.

In such snowy countries as Norway and Sweden, people build houses with sloping roofs so that snow will slide off easily. They also make the roofs strong enough to hold the weight of heavy snow.

Building methods and materials vary widely throughout the world. In regions with large forests, many people use wood to build homes. Lumber is easy to build with, but most wooden buildings are less sturdy than those made of stone or concrete. Builders almost anywhere can use concrete or bricks.

In areas with little rainfall, people construct many shelters of clay or mud. In Mexico and the southwestern United States, for example, people mix clay and dirt or mud with water to make adobe. Some people in India and other countries live in clay shelters. In dry areas of Africa, people make mud houses.

In wet tropical areas, moisture causes wood shelters to rot within a few years. People in these areas build houses from other materials. For example, in some parts

of Africa and on many Pacific islands, people weave the stems of tall grass into houses.

High-rise buildings made of steel and concrete are most common in such industrial countries as the United States and Canada. However, nearly every country has some steel and concrete structures. *Prefabricated buildings* consist of parts manufactured at a factory and then shipped to the construction site. There construction workers assemble the parts. Many prefabricated shelters use large amounts of plastic and other lightweight materials.

Other reasons. Tradition influences the type of shelters people build. Homes in Latin America, for example, show the influence of the early Portuguese and Spanish settlers. Many dwellings are constructed of adobe and have tiled roofs.

Special hazards also influence the shelters people build. In Japan, a country where earthquakes occur frequently, people make their homes of lightweight materials. Such homes are safer than structures of stone or other heavy materials if an earthquake topples them. In Indonesia, the Philippines, and other countries with much swampland, people erect houses on stilts to protect them from the water.

Shelter through the ages

Prehistoric times. Some early human beings lived in caves. They used stone tools to deepen the caves and smooth the walls. Other early people built dwellings from animal skins, stones, and clay bricks. Some houses stood on tall stilts for protection against animals. People who lived near lakes or rivers built such dwellings over water. They drove the stilts into the lake or river bottoms near the shore.

Ancient times. The rise of civilization led to the construction of better and larger buildings. Instead of simple shelters, people worked to build stronger defensive walls, more impressive palaces, and finer temples to honor their gods. These efforts brought a new art—architecture—into being. But the basic function of architecture was still to provide shelter. For example, the gigantic pyramids of ancient Egypt served not only as monuments to dead rulers but also as shelters for their remains. Ordinary Egyptians built flat-roofed homes of mud or sun-dried bricks. Wealthy Egyptians built beautiful, spacious homes of brick and wood.

The ancient Greeks built houses around courtyards. The Greeks also designed many temples and other public buildings.

Wealthy people in ancient Rome lived in large houses built of concrete and brick or stone. Some Roman houses included a central heating system and plumbing. The Romans also were the first people to use glass windowpanes. In addition to houses, the Romans constructed many large public shelters, including baths, temples, and theaters.

The Middle Ages lasted from about the A.D. 400's through the 1400's. In this period, architects designed magnificent cathedrals, such as those at Chartres, France, and Durham, England. Such buildings provided more than a roof over worshipers. Medieval Christians believed that, in a symbolic sense, God and the saints inhabited churches. As a result, they regarded cathedrals and other church buildings as shelters for holy beings.

By the late 900's, many European rulers lived in cas-

WORLD BOOK photo by Odyssey Productions

A house in the Midwestern United States—where summers are warm—includes a porch with screens on the windows and door. The screens let in breezes and help keep out insects.

WORLD BOOK photo by Odyssey Productions

High-rise apartment buildings are common in heavily populated areas, where land is scarce and expensive. These high-rises stand in Chicago's luxurious Gold Coast neighborhood.

tles. By the end of the 1100's, most castles had drawbridges, moats, and thick stone walls. In about the 1400's, Europeans began to build *half-timbered houses*. These structures had frameworks of timber, filled in with brick or interwoven branches plastered with mud or clay. Many such houses had a thatched roof.

The Renaissance, a period of European history that lasted from about 1400 to 1600, revived interest in the art and learning of ancient times. As a result, architects studied ancient Greek and Roman buildings and modeled their designs on those classical styles. Monarchs and other wealthy Europeans hired architects to design palaces inspired by Roman structures. Classical styles also influenced the houses of middle-class people during the Renaissance.

In early America. When Europeans first came to North America, Indians on the continent lived in several different types of shelters. Most Eastern Woodland tribes made dome-shaped wigwams of bark. Indians of the Western plains lived in cone-shaped tepees made of animal skins. In the Southwest, the Pueblo Indians built large houses of adobe and rocks. For a description of the shelters built by the Indians, see **Indian, American** (Shelter).

The first European settlers in North America made simple dwellings of logs and thatch or dried grass. Later, they built houses that resembled those in Europe. New England colonists used a type of overlapping siding called *clapboard* to keep out cold winds. Later, wealthy planters in the South built large homes with long porches and two-story columns. High ceilings helped keep the rooms cool in summer.

The Industrial Revolution, a period of rapid industrial growth and new inventions, began in Europe during the 1700's. It brought the development of many new building materials and construction methods. People began to build tall structures with frames made of steel or iron. Concrete also became a common construction material.

The Industrial Revolution also led to the construction of new types of shelters. For centuries, builders had concentrated on homes and such public buildings as churches and palaces. The Industrial Revolution required such new structures as factories and exhibition halls. For example, the Great Exhibition of 1851, an industrial fair held in London, was housed in a glass and iron structure called the *Crystal Palace*. The building, which resembled a huge greenhouse, was the first important structure to have prefabricated parts. As a result of the Industrial Revolution, modern builders can choose from a wide range of construction methods, building materials, and styles. G. L. Hersey

Artstreet

A house on stilts stands by a river in a swampy area of Papua New Guinea. Such shelters are elevated to provide protection from moisture on the ground and from floods.

Related articles in *World Book*. See House and Housing. See also the following articles:

Kinds of shelter

Castle	Lake dwelling	Tent
Hogan	Log cabin	Tepee
Houseboat	Mobile home	Wigwam
Igloo	Sod house	

Other related articles

Architecture	Inuit (Shelter)
Building construction	Pioneer life in America (A pioneer settlement)
Cave dwellers	Western frontier life in America (Frontier towns; Life in the country)
Colonial life in America (Houses)	
Indian, American (Shelter)	

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Shelterbelt, sometimes called a *windbreak,* is one or more rows of trees or shrubs planted to protect soil, livestock, and rural homes from the wind. Shelterbelts slow the wind near the ground, so soil is protected from wind erosion. The reduction of wind speed also conserves energy by decreasing the amount of heat loss from homes.

To protect farms from erosion, the United States Department of Agriculture in 1934 created the Shelter Belt Project, also known as the Prairie States Forestry Project. By 1942, about 223 million trees had been planted on more than 30,000 farms in the Great Plains. Renewed interest in energy and soil conservation led to the planting of more than 126 million trees in the Great Plains from 1979 to 1988. Gerald E. Schuman

Sheltie. See Shetland sheepdog.

Shenandoah National Park, *SHEHN uhn DOH uh,* lies in the heart of the Blue Ridge Mountains of Virginia. Most of the park is wilderness. Nearly all of the park is at least 2,000 feet (610 meters) above sea level, and it has about 60 wooded mountain peaks. The highest is

Hawksbill (4,049 feet, or 1,234 meters). The Skyline Drive runs 105 miles (169 kilometers) through the park along the crest of the mountains. Trails lead from the drive into the mountains. Azaleas, mountain laurel, dogwood, and other wildflowers grow in the park. Wildlife includes black bears, red and gray foxes, squirrels, opossums, skunks, minks, weasels, and ground hogs.

Shenandoah National Park is rich in history. George Washington passed through the area during the French and Indian wars. Battlefields of the American Civil War lie on both sides of the mountains. The park was established in 1935. For area, see **National Park System** (table: National parks). Critically reviewed by the National Park Service

See also **Virginia** (picture).

Shenandoah River, *SHEHN uhn DOH uh,* flows chiefly through the Shenandoah Valley between the Blue Ridge and Allegheny mountains in northern Virginia. For location, see **Virginia** (physical map). Two forks of the river join at Riverton, Virginia, to form a main body called the *river proper.* The river proper is about 55 miles (89 kilometers) long. The river proper and the north fork have a length of about 172 miles (277 kilometers). The river proper and the south fork are about 206 miles (332 kilometers) long. The Shenandoah is the largest tributary of the Potomac River. It joins the Potomac's main stream at Harpers Ferry, West Virginia. The Shenandoah is not navigable, but it furnishes electric power to the surrounding area. Michael P. O'Neill

Shenandoah Valley, *SHEHN uhn DOH uh,* is a beautiful rolling area in northern Virginia. It includes the seven counties drained by the Shenandoah River, and much of the area drained by the James River west of the Blue Ridge Mountains. The Massanutten Ridge and other prominent hills rise above the valley. For location, see **Virginia** (physical map). Livestock and animal products account for three-fourths of the valley's farm income. The region has many springs, caverns, and other tourist sites. During the American Civil War, the valley saw heavy fighting during General "Stonewall" Jackson's Valley Campaign of 1862, and in cavalry maneuvers involving generals Philip Sheridan and Jubal Early in 1864. Troops used the Valley Pike, now U.S. Route 11. Other highways run from the valley through gaps in the Blue Ridge Mountains. Michael P. O'Neill

Shenyang, *shuhn yahng* (pop. 4,655,280), also called Mukden, is the capital of Liaoning Province in China. It lies on the bank of the Hun River in northeastern China. For location, see **China** (political map). Five railroads meet at Shenyang. The city is in the center of the most populated part of Manchuria. It has three airports. Factories there produce metal products, machine tools, and airplanes.

The center and oldest part of Shenyang was built during the Middle Ages. It has narrow streets and is surrounded by high stone walls. Outside this section lies the Russian quarter, which the Russians built in the early 1900's, when they occupied Shenyang. The Japanese developed many suburbs of factories and homes when they invaded Manchuria in 1931. North of Shenyang is a beautiful park that has tombs of the Manchu emperors who once ruled the vast Chinese Empire.

A major battle of the Russo-Japanese War (1904-1905) took place in Shenyang. The Japanese invasion of Manchuria (1931) began with a clash between Japanese and Chinese forces near the city. Arif Dirlik

Shepard, Alan Bartlett, Jr. (1923-1998), became the first American in space. On May 5, 1961, astronaut Shepard rocketed 117 miles (188 kilometers) into space from Cape Canaveral, Florida. He landed 15 minutes later, 302 miles (486 kilometers) out in the Atlantic Ocean. In 1971, Shepard commanded Apollo 14, the third landing on the moon. He became the fifth astronaut on the moon. While on the moon's surface, Shepard conducted geological experiments.

Shepard made his historic first flight less than a month after Major Yuri Gagarin of the Soviet Union had orbited the earth in the world's first human space trip. Unlike Gagarin's spacecraft, Shepard's ship could be manually controlled during the flight. During this flight, Shepard lay on a contour couch inside a capsule mounted on a Redstone rocket. The capsule, named Freedom 7, weighed about 3,000 pounds (1,360 kilograms). Freedom 7 reached a top speed of 5,180 miles (8,336 kilometers) per hour. While reentering the earth's atmosphere, it endured forces 12 times as strong as the force of gravity on the earth's surface.

NASA

Astronaut Alan B. Shepard, Jr., was the first American in space. He also commanded the Apollo 14 moon landing.

Shepard was born in East Derry, New Hampshire. He graduated from the U.S. Naval Academy in 1944. After serving on a destroyer during World War II (1939-1945), he took flight training and became a Navy test pilot. In 1959, Shepard was chosen to be one of the first U.S. astronauts. He received the Distinguished Flying Cross and the Distinguished Service Medal of the National Aeronautics and Space Administration (NASA) for his first historic space flight. Shepard was grounded from 1963 to 1969 because of an ear disorder. In 1971, he became a rear admiral, the first astronaut promoted to this rank. In 1974, Shepard resigned from the astronaut program and the Navy. James R. Hansen

Shepard, Ernest Howard (1879-1976), was a British painter and illustrator. His illustrations in the 1920's for the Pooh stories and poems by A. A. Milne are particu-

larly well known (see Literature for children [picture: Winnie-the-Pooh]). Shepard also illustrated stories by Kenneth Grahame, including "The Reluctant Dragon" (1898) and *The Wind in the Willows* (1908), as well as books for older readers.

Shepard was born in London. Early in his career, he worked as a staff cartoonist for the magazine *Punch*. He wrote and illustrated an autobiography, *Drawn from Memory* (1957). Marilyn Fain Apseloff

Shepard, Sam (1943-), is an important American playwright and motion-picture actor. His best-known plays portray American society as dead, decaying, or destructive. Most of his works combine symbolism and ritual with elements of popular culture, such as Western movies, rock music, detective stories, and movies. Shepard has acted in several films, including *Days of Heaven* (1978), *The Right Stuff* (1983), and *Country* (1984).

Shepard won the 1979 Pulitzer Prize for drama for *Buried Child* (1978). This grim play concerns a young man and his girlfriend who visit the man's grotesque family in the rural Midwest. There they find a wasteland of hidden sin and guilt. Shepard also presented a nightmarish view of the American family in *The Curse of the Starving Class* (1977), *True West* (1980), and *A Lie of the Mind* (1985). He used rock music in *The Tooth of Crime* (1972), a symbolic story about two rock star rivals. In *Fool for Love* (1983), Shepard examined a romantic relationship between a half-brother and sister. His short stories were collected in *Cruising Paradise* (1996).

Shepard was born Samuel Shepard Rogers on Nov. 5, 1943, in Fort Sheridan, Illinois. He grew up in southern California and left home at age 19. Thomas P. Adler

Shepherd dog. See Sheepdog.

Sheraton, *SHEHR uh tuhn,* **Thomas** (1751-1806), was an English furniture designer. His reputation is based chiefly on a book of influential furniture designs called *The Cabinet-Maker and Upholsterer's Drawing Book* (1791-1794). Like other design books of the late 1700's, the *Drawing Book* recorded current tastes in furniture styles. Furniture that followed the styles in the book became known as Sheraton.

Furniture in the Sheraton style was popular in England from about 1790 to 1805 and in the United States from about 1795 to 1810. The style featured straight outlines, slender legs, and simple decorations. A typical Sheraton chair has a rectangular back. Common decorations include diamond and oval shapes and designs that suggest lyres or vases. Sheraton was born at Stockton-on-Tees, near Middlesbrough. Nancy E. Richards

See also Furniture (English neoclassical furniture).

Sherbrooke (pop. 75,916) is the trading center of a rich agricultural and industrial region in southern Quebec. It lies where the Saint Francis and Magog rivers meet, about 100 miles (160 kilometers) east of Montreal and about 30 miles (48 kilometers) north of the Canada-United States border (see Quebec [political map]). Sherbrooke factories make clothing, electronic and medical equipment, food products, furniture, iron and steel products, jewelry, lumber, machinery, rubber goods, and textiles. The region is the world's largest manufacturer of wooden hockey sticks.

Gilbert Hyatt, the first settler, built a homestead in 1796. The settlement was called Hyatt's Mills until 1818, when it was renamed in honor of a former governor general of Canada, Lord Sherbrooke. The city was incorporated in 1875. In 1896, it became one of the first Canadian cities to be provided with electric power. It has a mayor-council form of government. Charles Bury

Sheridan, Philip Henry (1831-1888), was a leading Union general in the American Civil War (1861-1865). He became famous especially for his victories as a cavalry leader in the Shenandoah Valley of Virginia.

Sheridan was born on March 6, 1831, in Albany, New York. In 1853, he graduated from the United States Military Academy. Sheridan, who became known as "Little Phil," was a captain when the Civil War began. From 1862 to 1863, he led a Union infantry division in battles at Perryville, Kentucky, and Stones River (Murfreesboro), Tennessee. His performance in these important battles earned him a promotion to major general of volunteers.

In 1863, Sheridan took command of a corps in the Army of the Cumberland. He led this corps in a battle at Chickamauga, Georgia. Later in 1863, in Tennessee, his corps broke the Confederate line at Missionary Ridge in the Battle of Chattanooga. Sheridan's action allowed Union General Ulysses S. Grant to win the battle. In 1864, Grant gave Sheridan command of the cavalry of the Army of the Potomac. In this command, Sheridan led a successful raid against Confederate forces in Richmond, Virginia. This raid resulted in the death of Confederate General Jeb Stuart.

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Philip H. Sheridan

In August 1864, Grant gave Sheridan command of all Union forces in Virginia's Shenandoah Valley. Grant ordered Sheridan to drive Confederate forces out of the valley and to destroy the valley's economic resources so that Confederate troops could not use them. In the valley, Sheridan's forces defeated Confederate troops under Lieutenant General Jubal A. Early at Winchester, Fisher's Hill, Waynesboro, and Cedar Creek.

At Cedar Creek, Early attacked Sheridan's forces when Sheridan was returning from a meeting in Washington, D.C. Sheridan rode about 11 miles (18 kilometers), from Winchester, to take command of his troops. When he reached them, they had already been driven back about 4 miles (6.4 kilometers) by the Confederate forces. But Sheridan rallied his troops and turned likely defeat into a Union victory. In April 1865, Sheridan helped Grant defeat Confederate General Robert E. Lee's forces at Five Forks, Virginia. This victory helped force a Confederate retreat from Richmond and Petersburg, Virginia.

After the Civil War, Sheridan commanded troops in the southern United States. From 1869 to 1883, he commanded the Division of the Missouri and became the foremost frontier general and Indian fighter in the country. In 1884, Sheridan succeeded William T. Sherman as general-in-chief of the U.S. Army. John F. Marszalek

Sheridan, Richard Brinsley (1751-1816), was an Irish dramatist and politician. During his brief writing career, he produced several sparkling comedies. In later life, he was a brilliant speaker in the British Parliament.

Sheridan was born in Dublin. While in his early 20's, Sheridan wrote *The Rivals* (1775). This comedy has a memorable character named Mrs. Malaprop who is a genius at using words incorrectly, as when she says, "Illiterate him, I say, quite from your memory." *The School for Scandal* (1777), Sheridan's finest play, is one of the great comedies of English drama. With glittering wit, it exposes society people who love malicious gossip. It also contrasts a careless but kind young man, Charles Surface, with his scheming and selfish brother Joseph. *The Critic* (1779), a short satiric play, wittily attacked theatrical fashions. Sheridan's other plays include the farce *St. Patrick's Day* (1775) and a comic opera, *The Duenna* (1775). He adapted Sir John Vanbrugh's comedy *The Relapse* (1696) into *A Trip to Scarborough* (1777).

In 1780, Sheridan was elected to Parliament, and until 1812, he devoted himself to politics. A gifted orator, Sheridan made a memorable speech in the trial of Warren Hastings in 1788 (see **Hastings, Warren**). In 1799, Sheridan wrote his last full-length play, *Pizarro,* a political tragedy adapted from the German play *Die Spanier in Peru.* A man of great charm and wit, Sheridan lived a busy social life among the rich and the powerful. He is best remembered for his witty plays, but he spent little of his life as a writer. Jack D. Durant

Sheriff, in the United States, is one of the chief administrative officers of a county. A sheriff's duties include maintaining order in county areas not controlled by city police, making arrests and taking charge of prisoners, and summoning and overseeing juries. A sheriff also carries out the judgments of the county court. For example, if the court gives a judgment against a debtor, the sheriff seizes that person's property and sells it to satisfy the claims of creditors. Sheriffs may perform these duties themselves, or they may give other persons the power to act in their name. These people are called *deputy sheriffs.* In most states, the voters elect the sheriff. In Canada, sheriffs are appointed.

The word *sheriff* comes from old England. Each *shire,* or county, had a chief official known as a *reeve.* The title *shire reeve* gradually came to be run together in the single word *sheriff.* Park Dixon Goist

See also **County; Law enforcement; Shire.**

Sherman, James Schoolcraft (1855-1912), served as vice president of the United States from 1909 to 1912 under President William Howard Taft. He died during the election campaign of 1912. His death created a unique situation in American politics. It was too late to replace him on the ballot, and more than 3 million people voted for Taft and Sherman. Sherman's eight electoral votes were cast for Columbia University President Nicholas Murray Butler.

Sherman was born in Utica, New York. He started practicing law in 1880 and served as mayor of Utica in 1884. He was in the U.S. House of Representatives from 1887 to 1891 and from 1893 to 1909. Robert W. Cherny

See also **Vice President of the United States** (picture).

Sherman, John (1823-1900), was an American statesman. He introduced the silver and antitrust laws that bear his name (see **Antitrust laws**). For almost 50 years Sherman held office in Washington, D.C., either as a Republican member of Congress or in the Cabinet. He was elected to the House of Representatives from Ohio in 1854, and seven years later was elected to the Senate. Sherman was secretary of the treasury from 1877 to 1881. He then returned to the Senate. His last public office was as secretary of state in 1897 and 1898.

Sherman was born in Lancaster, Ohio. During the Civil War (1861-1865), Sherman's brother William T. Sherman became a famous Union general (see **Sherman, William T.**). Arthur A. Ekirch, Jr.

Sherman, Roger (1721-1793), was the only person who signed all four of these great documents: the Articles of Association (1774), the Declaration of Independence (1776), the Articles of Confederation (1777), and the Constitution of the United States (1787). Sherman was born in Newton, Massachusetts. In 1743, he moved to Connecticut, where he became prominent in business and politics. Sherman served as judge of the Connecticut Superior Court from 1766 to 1789.

U&U

Roger Sherman

When the American independence movement began, Sherman was among the first to deny the supremacy of the British Parliament over the American Colonies. He was influential in the Second Continental Congress, where Massachusetts patriot leader John Adams said he was "as firm in the cause of American Independence as Mount Atlas." During the Constitutional Convention of 1787, Sherman presented the *Great Compromise,* sometimes called the *Connecticut Compromise.* It resolved the differences between the large and small states on representation in the national legislature (see **Constitution of the United States** [The compromises]). He served his state in the U.S. Congress as a representative from 1789 to 1791 and as a senator from 1791 to 1793. A statue of Sherman represents Connecticut in the U.S. Capitol. Jere Daniell

Sherman, William Tecumseh (1820-1891), was a leading Union general in the American Civil War (1861-1865). He became most famous for his "march to the sea," across Georgia, in 1864 and for his march through the Carolinas in 1865. On these marches, Sherman's troops destroyed much of the South's military and economic resources. From 1869 to 1883, Sherman served as commanding general of the United States Army.

In 1861, Sherman served as a colonel in the First Battle of Bull Run, also called the First Battle of Manassas. After the battle, he was promoted to brigadier general. In 1862, Sherman fought under General Ulysses S. Grant in the Battle of Shiloh. In July 1863, he helped Grant capture Vicksburg, Mississippi, a major Confederate stronghold on the Mississippi River. In November, he helped drive Confederate forces from Chattanooga, Tennessee.

In 1864, Sherman led an army that captured Atlanta, Georgia, and burned most of it. He then began his "march to the sea." On the march, his troops stripped barns, fields, and some houses. Sherman hoped that the terrible destruction would break the South's will to continue fighting. The march ended at Savannah, Georgia, a major port near the Atlantic Ocean. Sherman then

Brown Bros.

William T. Sherman

marched north through South Carolina. His troops continued to seize or destroy property in their path. Most of Columbia, the state capital, was burned. The Confederates blamed Sherman for the fire, but Sherman denied that his troops had set it. After leaving Columbia, Sherman continued north into North Carolina. There, Confederate General Joseph E. Johnston tried to stop Sherman. But Johnston had only about a third as many troops as Sherman did, and Sherman continued his march. In April 1865, Johnston surrendered to Sherman near Durham, North Carolina. But President Andrew Johnson thought the terms granted by Sherman were too generous and rejected them.

Sherman was born in Lancaster, Ohio. His father, an Ohio Supreme Court justice, died when William was 9 years old. After his father's death, William went to live with the family of Thomas Ewing, an Ohio politician. In 1840, Sherman graduated from the United States Military Academy at West Point. He fought in Florida in the Second Seminole War (1835-1842). After the American Civil War, Sherman wrote his *Memoirs* (1875). Both the Democratic and Republican parties repeatedly asked him to run for president, but he refused. In 1884 he told the Republicans, "I will not accept if nominated and will not serve if elected." John F. Marszalek

Additional resources

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Sherman Antitrust Act. See Antitrust laws; Labor movement (Opposition to unions).

Sherman's march. See Georgia (The Civil War).

Sherpas, *SHUR puhz,* are a people who live mainly in the mountains of the Himalayan range in northeast Nepal. Many of the approximately 25,000 Sherpas live near Mount Everest, the world's highest mountain. Some Sherpas live in northeast India.

The Sherpas have traditionally made their living by farming. Their chief crop is potatoes, but they also grow barley, corn, and wheat. Sherpas also raise *yaks,* a type of ox that thrives in high altitudes. Since the early 1950's, many Sherpas have worked as guides for tourists and porters for mountain climbing expeditions in the Himalaya. In 1953, a Sherpa named Tenzing Norgay and a New Zealand climber named Edmund Hillary became the first people to reach the top of Mount Everest.

Most Sherpas cannot read or write. But since the early 1960's, the Sherpas have built schools in several villages. As a result, some Sherpa children have attended high school, and a few have gone on to college.

The Sherpas probably moved to Nepal in the early 1500's from eastern Tibet. They still follow many of the customs and traditions of their Tibetan ancestors. For example, the Sherpa language is a Tibetan dialect. Most Sherpa women and some men dress in Tibetan clothing. The Sherpas also practice the traditional religion of Tibet, a form of Buddhism called *Lamaism.* James F. Fisher

See also Tenzing Norgay.

Sherwood, Robert Emmet (1896-1955), was an American playwright, journalist, and biographer who stressed the evils of war in his writings. His play *Idiot's Delight* (1936) lamented the approaching outbreak of war in Europe. *Abe Lincoln in Illinois* (1938) used Lincoln's own words to show the necessity of firm action in the face of war. *There Shall Be No Night* (1940) opposed the Soviet Union's invasion of Finland. It was also Sherwood's stand against what he called the hysterical desire of people to escape from reality. All three of these plays won Pulitzer Prizes.

Sherwood was born in New Rochelle, New York. In 1920, he joined *Life* magazine, where he became a nationally known film critic. He won an Academy Award for his screenplay for *The Best Years of Our Lives* (1946). Sherwood's first produced play, *The Road to Rome* (1927), was a satire on Hannibal's campaign against Rome. It said every sacrifice in the name of war is wasted. *The Petrified Forest* (1935) showed criminal morality triumphing in the world. During World War II (1939-1945), Sherwood wrote speeches for President Franklin D. Roosevelt. Sherwood won a Pulitzer Prize for his biography *Roosevelt and Hopkins: An Intimate History* (1948). Frank R. Cunningham

Shetland Islands make up the northernmost part of the United Kingdom. They lie in the Atlantic Ocean, near the North Sea. They are part of Scotland. They lie about 100 miles (160 kilometers) north of the Scottish mainland and about 200 miles (320 kilometers) west of Norway (see Europe [political map]).

The Shetland Islands consist of about 100 islands, but people live on fewer than 20 of them. The islands have a total land area of 552 square miles (1,430 square kilometers) and a population of about 23,500. Mainland is the largest island in both area and population. Most Shetlanders are of Scandinavian ancestry.

The wild natural beauty of the Shetland Islands attracts many tourists, especially in midsummer when daylight occurs almost around the clock. A fishing industry based in Lerwick, the largest town, forms a major part of the islands' economy. The islanders also raise world-famous Shetland ponies and Shetland sheep. Many women of the islands knit the soft, fine wool of the sheep in famous patterns called Shetland and Fair Isle. The raising of crops is difficult because the islands have a damp, windy climate and poor soil. Since the 1970's, the production of oil from nearby wells in the North Sea has brought much wealth to the Shetland Islands. The islands have a huge oil tanker terminal and bases that service offshore drilling operations.

Archaeological evidence indicates that people lived in the Shetland Islands about 4,000 years ago. Vikings from Norway conquered the islands in the A.D. 800's. Norway ruled them from then until the late 1400's. Scotland (now part of the United Kingdom) acquired the islands in 1469, when King James III of Scotland married Princess Margaret of Norway and Denmark. H. R. Jones

Shetland pony is a small breed of horse. A Shetland stands from 32 to 46 inches (81 to 117 centimeters)

high at the shoulder. The breed originated on Scotland's Shetland Islands. Early Shetlands had thick bodies and legs. These strong ponies were used as saddle and pack animals and to pull carts in coal mines. Some modern Shetlands have retained the powerful build of their ancestors. Others have been crossbred with lighter ponies to produce more slender, graceful animals. Shetlands have thick manes and tails. Most are black or brown.

People usually keep Shetlands as pets or as children's mounts. The ponies often have independent personalities and require constant attention when inexperienced riders are on their backs. Steven D. Price

Shetland sheepdog, also called the *sheltie,* is considered one of the most beautiful of all herding dogs. This small, rough-coated breed was developed to herd the small livestock of Scotland's Shetland Islands. It stands from 13 to 16 inches (33 to 41 centimeters) high at the shoulder and somewhat resembles a miniature collie. The sheltie looks dainty and fragile, but it is a rugged dog capable of hard work. It has an intelligent, obedient personality, and it is gentler than some heavier types of herding breeds. Shelties make good pets and watchdogs. See also **Dog** (picture: Herding dogs).

Critically reviewed by the American Kennel Club

Shevardnadze, *shehv ahrd NAHD zeh,* **Eduard Amvrosiyevich** (1928-), was elected president of the country of Georgia in 1995. From 1992 to 1995, he was chairman of Parliament, then the country's highest post. From 1985 to 1990, he was minister of foreign affairs for the Soviet Union. In this post, he led an effort to reform Soviet foreign policy by moving away from strict Communist principles. He resigned in 1990, complaining of criticism of his reform efforts and warning of the threat of dictatorship.

UPI/Bettmann

Eduard A. Shevardnadze

Formerly a republic of the Soviet Union, Georgia declared its independence in April 1991. The Georgian people elected Zviad Gamsakhurdia president in May. Opposition leaders soon accused Gamsakhurdia of moving toward dictatorship. A military council took over in January 1992. The council invited Shevardnadze to head the government until elections could be held. In elections that October, Shevardnadze won the post of chairman of Parliament. In 1995, after a new constitution took effect, he was elected president.

Shevardnadze was born in Mamati, southwest of Samtredia, in Georgia. He joined the Soviet Communist Party in 1948. He served as leader of Georgia's Communist Party from 1972 to 1985. In 1985, he became a voting member of the Politburo, the chief policymaking body of the Soviet Communist Party. Nicolai N. Petro

Shevchenko, *shuhf CHAYN kaw,* **Taras,** *TA ruhs* (1814-1861), was a Ukrainian patriot who became Ukraine's most famous poet. His poems stress the hard life of Ukrainians and their desire for independence from Russia. Shevchenko's writing is colorful and often includes everyday language. He is considered the founder of modern Ukrainian literature.

Shevchenko was born a serf in the village of Morintsy, near Kiev. In 1838, wealthy admirers bought his freedom while he was studying art in St. Petersburg. Shevchenko wrote against serfdom and monarchy. In 1847, the Russian government punished him by forced military service in the Ural Mountains, where he stayed 10 years. His works include *Minstrel* (1840), *Katerina* (1840), *Haydamaki* (1841), and *Dream* (1844). Joseph T. Fuhrmann

Shi Huangdi, *shihr hwahng dee* (259?-210 B.C.), also spelled *Shih Huang-ti,* was a Chinese emperor who founded the Qin dynasty (221-206 B.C.). He created the first united Chinese empire and began construction of the Great Wall of China. His name means *first emperor.*

Shi Huangdi became ruler of the Chinese state of Qin in 246 B.C. Between 230 and 222 B.C., he conquered other states and replaced local rule with a strong central government. In 221 B.C., he proclaimed himself China's first emperor. To keep out northern invaders, he linked short walls built by earlier rulers, marking the start of the Great Wall of China. Shi Huangdi standardized weights and measures, laws, and the Chinese script. He also executed many who opposed him and used forced labor to build the Great Wall. He burned writings that might have turned people against him. Grant Hardy

See also **Great Wall of China; Qin dynasty.**

Shiba inu, *SHEE buh EE noo,* is a small dog that originated thousands of years ago in Japan. The Japanese used the dog chiefly to hunt birds and small game. The name *shiba inu,* Japanese for *brushwood dog,* may refer to the brushwood bushes where the dogs often hunted. Today, the shiba is kept mainly as a pet and watchdog.

Reynolds Photography

The shiba inu originated in ancient Japan.

The shiba inu stands 13 $\frac{1}{2}$ to 16 $\frac{1}{2}$ inches (34 to 42 centimeters) tall at the shoulder and weighs up to 25 pounds (11 kilograms). It has a thick, muscular neck, and its tail curls up over the back. The shiba has a soft, dense undercoat and a stiff outer coat. Common coat colors are red with a sparse black outer coat, and black-and-tan, with white or cream markings on the chest, legs, muzzle, and cheeks, and above the eyes.

Critically reviewed by the National Shiba Club of America

Shield was the chief means of personal protection in war from earliest times until the invention of firearms during the 1300's. Shields were carried in one hand or

WORLD BOOK illustrations by Linden Artists Limited

Shields used by soldiers, noblemen, and warriors varied in size, shape, and design. Many decorated shields served not only for protection in battle but also to identify the owner.

on the arm to ward off enemy blows. The other hand was free to use a club, sword, or spear.

The earliest shields were made of bullhide or wood. Some were covered with metal. They were of many sizes and shapes. The ancient Egyptians had large shields that were often oblong in shape with a curved top. Sumerian and Assyrian shields were round. The ancient Greek soldier carried a heavy round or oval shield. The Romans introduced a rectangular curved shield made of leather-covered wood.

During the Middle Ages, armored knights used a small triangular shield. After helmets covering the face were introduced, a knight was recognized by the coat of arms painted on his shield. Foot soldiers carried a small round shield called a *buckler.* Archers reloaded their bows behind a *pavise,* a large shield set on the ground. In the 1300's, knights began wearing *plate armor* consisting of large pieces of steel, and they no longer needed shields. Shields were also discarded because they offered little protection against guns.

Shields have special uses today. For example, police officers sometimes carry shields made of synthetic materials as protection during riots. Karin N. Mango

Shields, James (1806-1879), served as governor of the Oregon Territory and as a brigadier general of volunteers in the Mexican and Civil wars. A Democrat, he also served as a U.S. senator from Illinois, Minnesota, and Missouri. He was born in County Tyrone, Ireland. He came to the United States in 1826. Illinois placed a statue of Shields in the U.S. Capitol in 1893. Jerome O. Steffen

Shih Huang-ti. See Shi Huangdi.

Shih Tzu, *shee dzoo,* is a breed of small dog that originated in China. It measures from 8 to 11 inches (20 to 28 centimeters) high at the shoulder and weighs from 9 to 16 pounds (4 to 7 kilograms). The Shih Tzu has a round, broad head; large round eyes; and a short, square snout. It has a long, luxurious coat that comes in a large range of colors. Its tail is also thickly covered with hair.

Critically reviewed by the American Shih Tzu Club

Shiites, *SHEE eyets,* are the followers of the Shiah division of the Islamic religion. The Shiites are the smaller of the two major divisions of Islam, with less than 20 percent of the believers. The other and larger division is called Sunni, and its followers are called Sunnites. Azerbaijan, Bahrain, Iran, and Iraq are the only Islamic countries with a Shiite majority, though there are large minorities in India, Lebanon, Pakistan, and the Arab countries of the Persian Gulf region.

The Shiite origins lie in the controversies about the leadership of the Islamic community after the death of the Islamic prophet Muhammad in A.D. 632. A majority of *Muslims* (followers of Islam) supported the election of Abu Bakr, one of Muhammad's prominent disciples, as *caliph* (leader or successor). This group became the Sunnites. But a minority argued that Muhammad had specifically designated Ali, his cousin and the husband of his daughter Fatimah, as leader. This group, which called itself *Shiah Ali* (Party of Ali), became the Shiites. They accused Abu Bakr and the two rulers who followed him of wrongly seizing power from Ali.

The Shiites call the person they believe to be the rightful leader of Islam *Imam.* According to Shiite teaching, the Imam is a spiritual, as well as an earthly, leader. Each new Imam must be a direct descendant of Ali.

Walter Chandoha

The Shih Tzu is a tiny dog that originated in China.

The Shiites believe that the Imam is protected from sin or error and that he is everpresent in the world as the continuing source of divine guidance.

Ali was the first Imam. Following his assassination in 661, his son, Hasan, became Imam. Ali's second son, Husayn, succeeded Hasan as Imam. The most important Shiite holy day practice observes mourning for the death of Husayn at the hands of the caliph's troops in 680. Charles J. Adams

See also **Islam; Muhammad; Muslims; Safavid dynasty; Sunnites.**

Shilling was a coin in the British money system. It was equal to 12 *pence* (pennies) and was $\frac{1}{20}$ of a pound sterling. In 1971, British authorities replaced the old penny with a new one of greater value. At the same time, the shilling was replaced with a five-pence coin whose value equaled that of the shilling. The coin that had served as the shilling remained in circulation as a five-pence piece until 1991. The shilling is still the monetary unit of some African countries.

Shiloh, Battle of. See **Civil War** (The war in the West; table: Major battles).

Shingles is a painful disease in which a rash with small clusters of blisters forms on the skin. It occurs chiefly among elderly persons. Shingles is caused by the *varicella-zoster virus,* which is one of the herpesviruses. This same virus causes chickenpox (see **Chickenpox**). Shingles affects persons who have had chickenpox and have developed partial *immunity* (resistance) to the virus. Physicians call shingles *herpes zoster.*

An attack of shingles begins after the virus infects a nerve root. Within days, the skin area supplied by this nerve becomes extremely sensitive. At the same time—or a day later—a red rash with watery blisters appears. In most cases, the pain and rash affect only the left or only the right side of the body, according to the path of the infected nerve. After a few weeks, the blisters dry up and disappear. But the pain may continue for many months. Physicians treat shingles with painkilling drugs and soothing lotions. Severe cases may require treatment with a drug called *acyclovir.* Yelva Liptzin Lynfield

See also **Herpesvirus.**

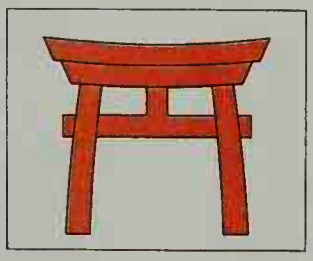
Shinn, Everett (1876-1953), was an American painter and illustrator. He is best known for his portrayals of theater life, with its changing moods and lively movement. In addition, Shinn drew and painted New York City streets and urban activities.

Shinn was born on Nov. 7, 1876, in Woodstown, New Jersey. He began his career in 1893 as a newspaper illustrator and cartoonist. He illustrated for magazines in his later years. The influence of his work as an illustrator can be seen in his brilliant draftsmanship. In 1908, Shinn joined a group of realistic painters organized by Robert Henri called *The Eight,* later called the *Ashcan School* (see **Ashcan School**). In this group, Shinn painted with the lightest and most delicate touch. Charles C. Eldredge

Shinto, *SHIHN toh,* is the oldest surviving religion of Japan. The word *Shinto* means *the way of the gods.* Shintoists worship many deities, which they call *kami.* According to Shinto, kami are the basic force in mountains, rivers, rocks, trees, and other parts of nature. Shinto also considers kami the basic force in such processes as creativity, disease, growth, and healing.

Shinto emphasizes rituals. It does not have an elaborate philosophy, and, unlike a large number of religions, Shinto does not stress life after death.

About 2 $\frac{2}{3}$ million people practice traditional Shinto. Many worship at small shrines in their homes. Roadside shrines dedicated to certain kami are also common. Some public shrines consist of many buildings and gardens. Individual worshipers recite prayers and offer gifts of cakes, flowers, and money to the kami.



A wooden gate called a *torii* is the symbol of Shinto. A torii stands at the entrance of a Shinto shrine. It consists of two posts connected by crossbars. The posts represent pillars that support the sky, and the crossbars symbolize the earth.

On certain occasions, Shinto priests lead ceremonies called *matsuri.* One of the most important Shinto matsuri is the Great Purification Ceremony. It consists of a confession of sins committed by individuals and by the nation as a whole, followed by a request that the kami remove the impure conditions caused by these sins. Other ceremonies deal with such basic goals as long life, peace, abundant harvests, and good health.

No one knows when or how Shinto began. But Shintoists have always worshiped the kami through nature. Shinto myths appear in the *Nihongi* (*Chronicles of Japan*) and the *Kojiki* (*The Record of Ancient Matters*), both written in the A.D. 700's. These myths tell how the kami created the world and established customs and laws. According to Shinto mythology, the sun goddess was the ancestor of Japan's imperial family.

Beginning about the A.D. 500's, the Chinese philosophies of Buddhism and Confucianism began to influence Shinto. Shintoists identified Buddhist gods as kami, and shrines adopted Buddhist images to represent the kami. Buddhist ceremonies were used for funerals and memorial services. Under the influence of Confucianism, Shinto developed such moral standards as honesty, kindness, and respect for one's elders and superiors.

In the late 1800's, the Japanese government invented *State Shinto,* which stressed patriotism and the divine origins of the Japanese emperor. After Japan's defeat in World War II in 1945, the emperor denied that he was divine, and the government abolished State Shinto.

During the 1800's and 1900's, hundreds of *New Religions* became popular in Japan. Many of these were Shinto denominations that centered around the teachings of a particular person. Most promote group worship, charity work, and the healing of body and mind. Today, nearly all of Japan's people perform periodic Shinto rites, though they do not consider themselves to be Shintoists. Alan L. Miller

See also **Japan** (Religion); **Religion** (picture: A Shinto festival).

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Farrell Grehan, Photo Researchers

Sturdy cargo ships like these freighters in the harbor at Rotterdam, the Netherlands, are the workhorses of the sea. They carry much of the trade among the countries of the world.

Ship

Ship is one of the oldest and most important means of transportation. Every day, thousands of ships cross the oceans, sail along seacoasts, and travel on inland waterways. Trade among countries depends heavily on ships. For example, ships carry wheat from Canada to Germany and machinery from Germany to Chile. They haul copper from Chile to Japan and Japanese automobiles to the United States. Ships transport American corn to Ethiopia, coffee from Ethiopia to France, and French plastics to Canada.

Many kinds of ships are used to carry the world's trade. Giant tankers haul petroleum, soybean oil, wines, and other liquids. Refrigerator ships carry fresh fruits, meats, and vegetables. Vessels called *dry bulk carriers* haul such cargoes as grain, ore, and sand. General cargo ships transport everything from airplane engines to zippers. Passenger liners carry travelers across the oceans and vacationers on cruises to the Mediterranean and Caribbean seas and other scenic areas.

For several thousand years, people have gone down to the sea in ships. They have been drawn by the mysteries of the sea and by its promise of adventure. More important, people have sailed the seas to explore, to settle, to trade, and to conquer. In 1492, Christopher Columbus braved the unknown waters of the Atlantic Ocean in three small sailing ships and reached the New World. During the 1500's, Spanish ships carried *conquistadors* (conquerors) to Latin America. The conquistadors soon won control of much of the region for Spain. An old trading ship called the *Mayflower* brought the first Pilgrim settlers to North America in 1620. From the 1600's to the 1800's, big sailing ships called *East Indiamen* carried silks, spices, and other riches from the Far East to Europe.

During the mid-1800's, steam-powered ships began to replace sailing vessels. The world quickly became smaller as steamships crossed the seas in a fraction of the time that sailing ships needed. Thus, ships have brought countries and peoples closer and made them dependent economically on one another.

Throughout history, nations have become rich and powerful by controlling the seas in war and peace. When countries have lost that control, they have declined. Today, ships are as important as ever to a country's prosperity and strength. The United States, the world's leading trading nation, depends largely on ships for its imports and exports. The economies of Germany, Japan, the United Kingdom, and many other countries would soon be badly crippled if there were no ships to bring in food and raw materials and to carry out manufactured goods. All the great trading nations try to have a large *merchant marine*. A merchant marine consists of the commercial, or merchant, ships of a country.

The difference between a ship and a boat is chiefly a matter of size. Large oceangoing vessels are called *ships*. All other craft are called *boats*.

This article deals mainly with merchant vessels. For information on naval vessels, see the *World Book* articles on Navy and Warship. For information on pleasure boats, see Boating.

Philip Chadwick Foster Smith, the contributor of this article, is a maritime historian. The historical drawings in this article were critically reviewed by Robert H. Burgess, Curator of the Mariners Museum, Newport News, Virginia.

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Luxurious cruise ships sail to the Caribbean and Mediterranean seas and other scenic areas. They provide fine food, excellent accommodations, and a wide variety of recreational activities.

History

The first "ship" was probably a log that was used to cross a lake or river. People probably used their hands as paddles. Later, people learned to build rafts by lashing logs together. In time, they discovered how to make dugouts and bark canoes. In regions where wood was scarce, early people made boats of other materials. For example, they sewed animal skins into a bag, which they then inflated and used as a float. Several floats tied together could support a raft. In some areas, the people found that little clay pots tied together could hold up a raft. They also learned that a large pot made a boat for one person.

In ancient Egypt and certain other regions, the people made their first rafts of bundles of reeds. In time, the Egyptians learned to lash bundles of reeds together to make boats that had a spoonlike shape. By about 4000 B.C., they had learned to build long, narrow boats powered by a row of oarsmen. During the next 1,000 years, the Egyptians made two more great advances in the development of ships. By about 3000 B.C., they had discovered that sails could harness the power of the wind and propel their boats. In addition, the Egyptians had learned to build boats out of planks of wood. After people knew how to make plank boats, they could even build ships—vessels that are big enough to cross the oceans.

The age of sailing ships

The basic pattern for ships became set with the invention of the sail and then of the vessel built of planks. For about the next 5,000 years, shipbuilders concentrated on designing bigger and bigger ships and on improving the *rig*—the sails with their masts and ropes. Shipbuilders of ancient times succeeded in building ever-larger ships, but they made little progress with the rig. Big improvements in the rig began during the 1400's and reached a high point with the development of the great sailing ships of the mid-1800's.

Egyptian ships. The ancient Egyptians designed many kinds of vessels, including small, graceful canoes,

Some important dates in ship development

3000's B.C. The Egyptians discovered sails and learned to build boats out of planks of wood.

c. A.D. 1200 Shipbuilders in northern Europe introduced the stern rudder.

c. 1450 Mediterranean shipbuilders developed the full-rigged sailing ship.

1807 Robert Fulton of the United States built the first commercially successful steamboat.

1818 The United Kingdom launched the *Vulcan,* the first known all-iron sailing ship.

1819 The American ship *Savannah* became the first steam-powered vessel to cross the Atlantic Ocean, though it used its engines only 105 hours during the 29-day voyage. The *Savannah* used sails the rest of the trip.

1836 Francis Pettit Smith, an Englishman, and John Ericsson, a Swede, patented propellers to drive steamboats.

1838 The United Kingdom's *Sirius* became the first ship to offer regular service across the Atlantic Ocean under steam power alone.

1897 Charles A. Parsons of England demonstrated the efficiency of steam turbines in his launch, the *Turbinia.*

1910-1911 The first motorships went into operation.

1959 The United States launched the *Savannah,* the first nuclear-powered merchant ship.

1980 The tanker *Seawise Giant* (later renamed the *Jahre Viking*), launched in 1979, was lengthened to become the world's largest ship. It is 1,504 feet (458 meters) long.

beautiful yachts, and heavy freighters. Their most outstanding achievement was probably the huge barges that carried enormous stone pillars called *obelisks* from quarries up the Nile River. The biggest barges measured more than 200 feet (61 meters) long and carried 750 short tons (680 metric tons) of cargo.

One sail and a line of oarsmen on each side propelled the yachts and other light Egyptian vessels. The heavier craft were driven by only a sail. The Egyptians used a rectangular sail, which is called a *square sail.* At first, they made the sail tall and narrow. But after 2000 B.C., they made it much wider than it was tall. The Egyptians steered their ships with large oars on each side near the stern.

The Egyptians built their vessels chiefly for use on the Nile. As a result, they made all their craft—even ships used on the sea—rather light. Today, boats of planks are built by first making a skeleton of *keel* (backbone) and ribs and then fastening the planks of the hull to the ribs. But the Egyptians built their river craft without a keel or ribs. They simply fitted the planks together by means of joints to form the hull. These vessels were sturdy enough to sail on the Nile, but they were too weak for the rougher Mediterranean Sea.

The Egyptian seagoing ships probably had some kind of keel and a few ribs. But the bow and stern of these ships tended to droop, especially in rough seas. So the Egyptians wound a heavy rope around the bow, stretched it tightly across the deck, and looped it around the stern. The rope strengthened the vessels and kept the bow and stern from sagging. The Egyptians sailed chiefly on the Red Sea and along the eastern shore of the Mediterranean.

Minoan and Mycenaean ships. The Minoans, who lived on the island of Crete, became the first true seafaring people of the Mediterranean region. As early as 2500 B.C., their ships ranged the eastern Mediterranean and as far west as the island of Sicily. About 1450 B.C., the Mycenaeans, who lived on what is now the Greek mainland, won control of the sea. The Minoans and

Prehistoric and ancient Egyptian ships

The first "ships" included dugouts, log rafts, and boats made of hides stretched over a frame. The ancient Egyptians made some of the greatest advances in the development of ships. By about 4000 B.C., they had learned to build long, narrow reed boats powered by a line of paddlers. By about 3000 B.C., the Egyptians had discovered sails and had learned to construct boats of planks of wood. People could then build ships—vessels large enough to cross the open seas.

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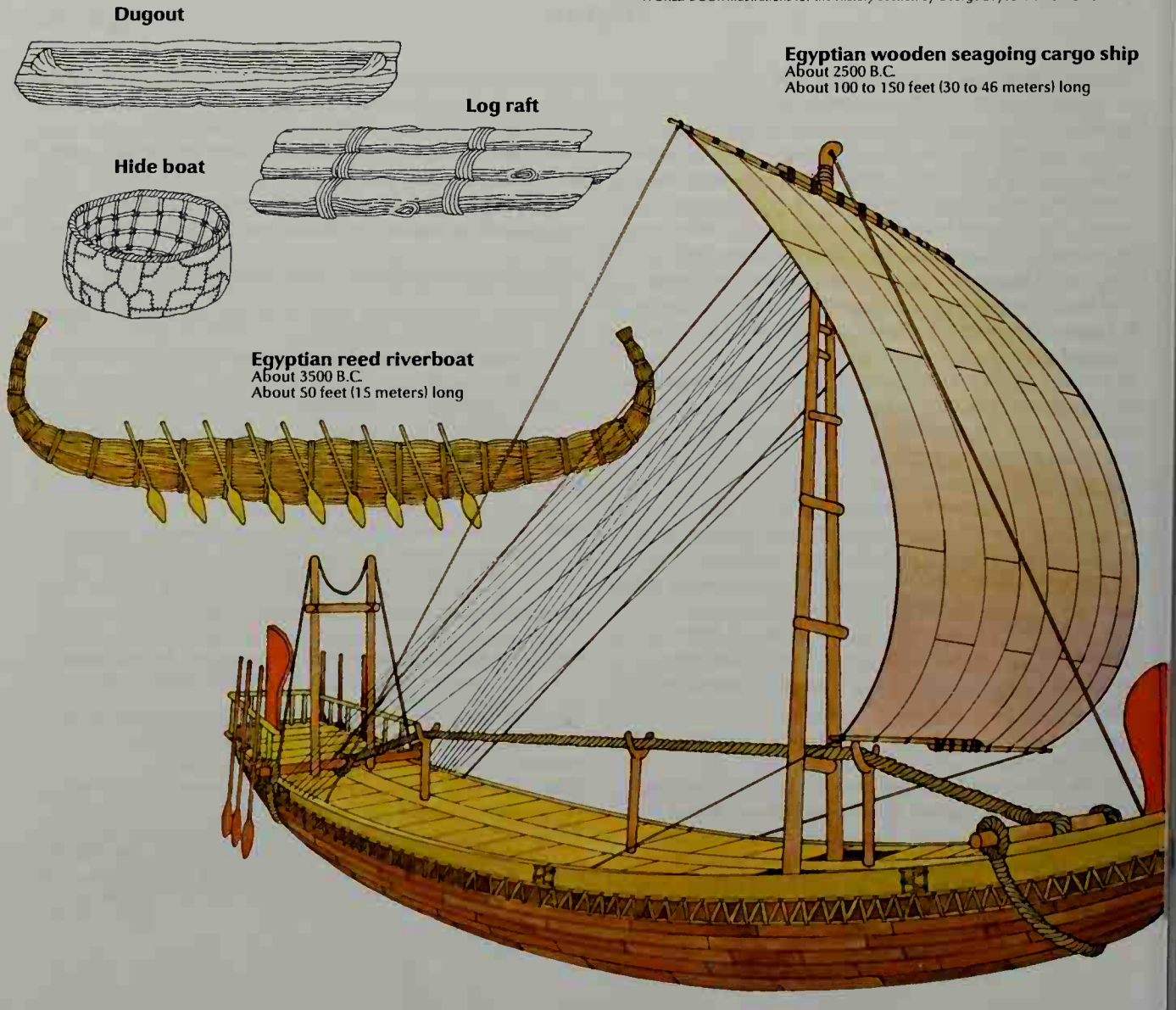


Mycenaeans both helped develop the seagoing sailing ship. However, historians know little about their ships. All they know for sure is that these peoples built cargo vessels that were sturdy and roomy and had one square sail. The Minoans and Mycenaeans also built strong war *galleys*—long, narrow ships that were propelled by a row of oarsmen on each side.

Phoenician and Greek ships. Scholars know much more about the ships used on the Mediterranean Sea after about 1200 B.C. At that time, the leading seafaring peoples were the Phoenicians, who lived along the eastern shore of the Mediterranean, and the Greeks.

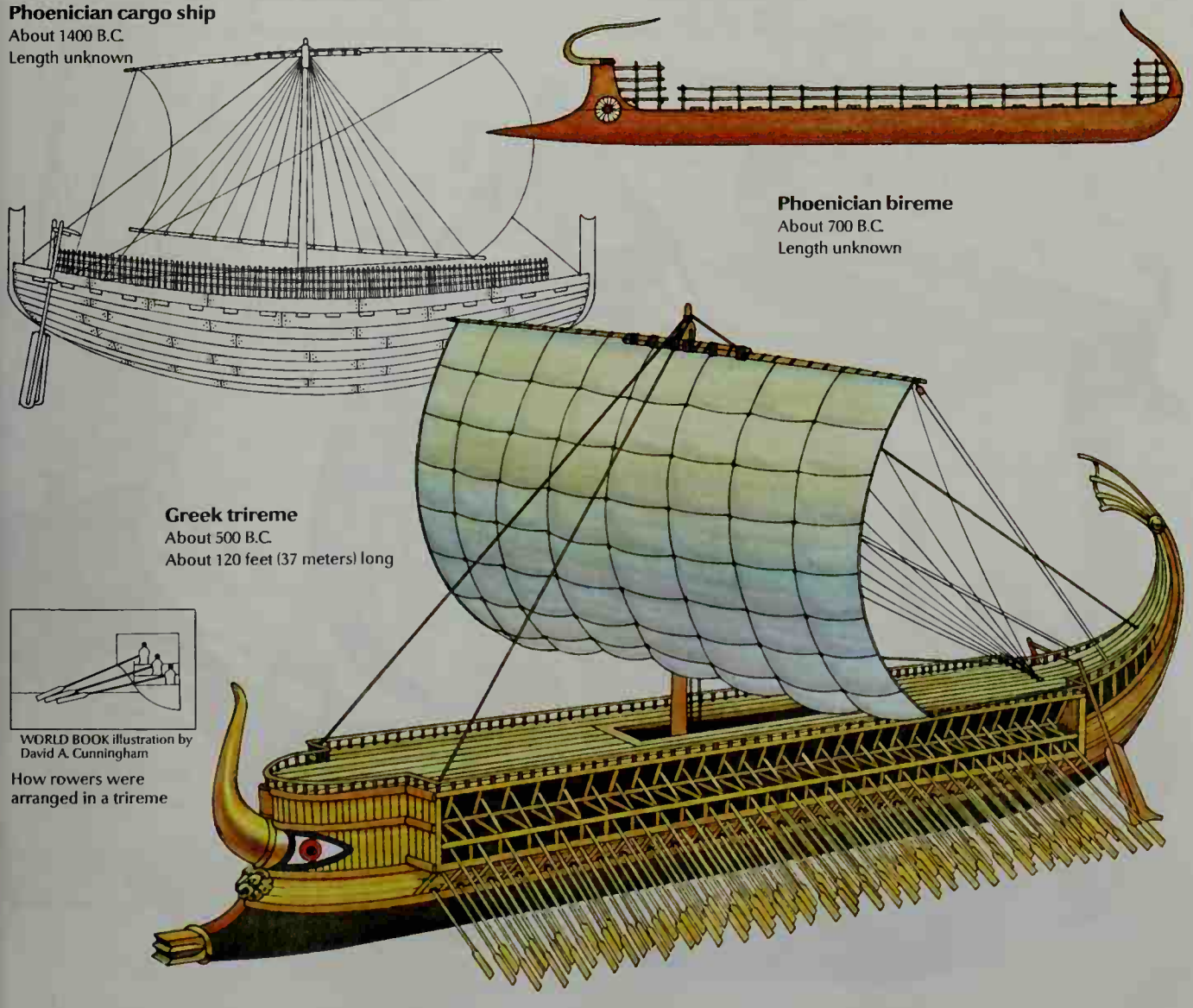
The Phoenicians and Greeks built broad, roomy cargo ships and greatly improved the ship rig. By about 500 B.C., they built vessels with two masts. The second mast sloped forward over the bow. It supported a small square sail that made steering easier. After 300 B.C., the Greeks set a triangular sail above the mainsail. On their biggest ships, they added another square sail near the stern. This simple four-sail rig was the most advanced rig ever developed by the peoples of ancient times. As a result, ancient ships were slow and could travel at an average speed of only about 5 knots with the wind. The standard Greek freighter measured about 100 feet (30 meters) long and could carry 100 to 200 short tons (90 to 180 metric tons) of cargo.

The Phoenicians and Greeks used galleys for warships. Their galleys were driven by oars. After 1000 B.C., a large, sharp *ram* (point) was added to the prow at the water line for use in battle. By about 700 B.C., the Phoenicians built *biremes,* galleys with two *banks* (rows) of oarsmen on each side. The Greeks adopted these ships and made them lighter and faster. By about 500 B.C., the Greeks developed the *trireme.* It had three banks of rowers on each side.

The Greeks—and later the Romans—built the hull of their ships first, as the Egyptians had done. But they used more and tighter joints to fit the planks together. They also inserted a system of ribs to stiffen the hull. As a result, Greek and Roman ships had strong hulls.

Phoenician and Greek ships

The Phoenicians left no records of how their ships looked. The little that scholars know about these vessels comes from other ancient peoples. The Greeks, however, pictured their ships on pottery. The Phoenicians and Greeks built broad, roomy cargo ships and long, narrow war galleys. A ram was added to the galley's prow after 1000 B.C. By about 500 B.C., the Greeks developed the greatest warship of ancient times, a three-banked galley called a *trireme.*



Roman ships. The Romans became rulers of the Mediterranean region during the 100's B.C. They used chiefly the same kinds of ships the Greeks had used.

The Romans built up the largest merchant fleet of ancient times. Their biggest cargo ships carried grain from Alexandria, Egypt, to Rome. The largest ones measured up to 180 feet (55 meters) long and 45 feet (14 meters) wide. They could haul more than 1,000 short tons (910 metric tons) of cargo and as many as 1,000 passengers.

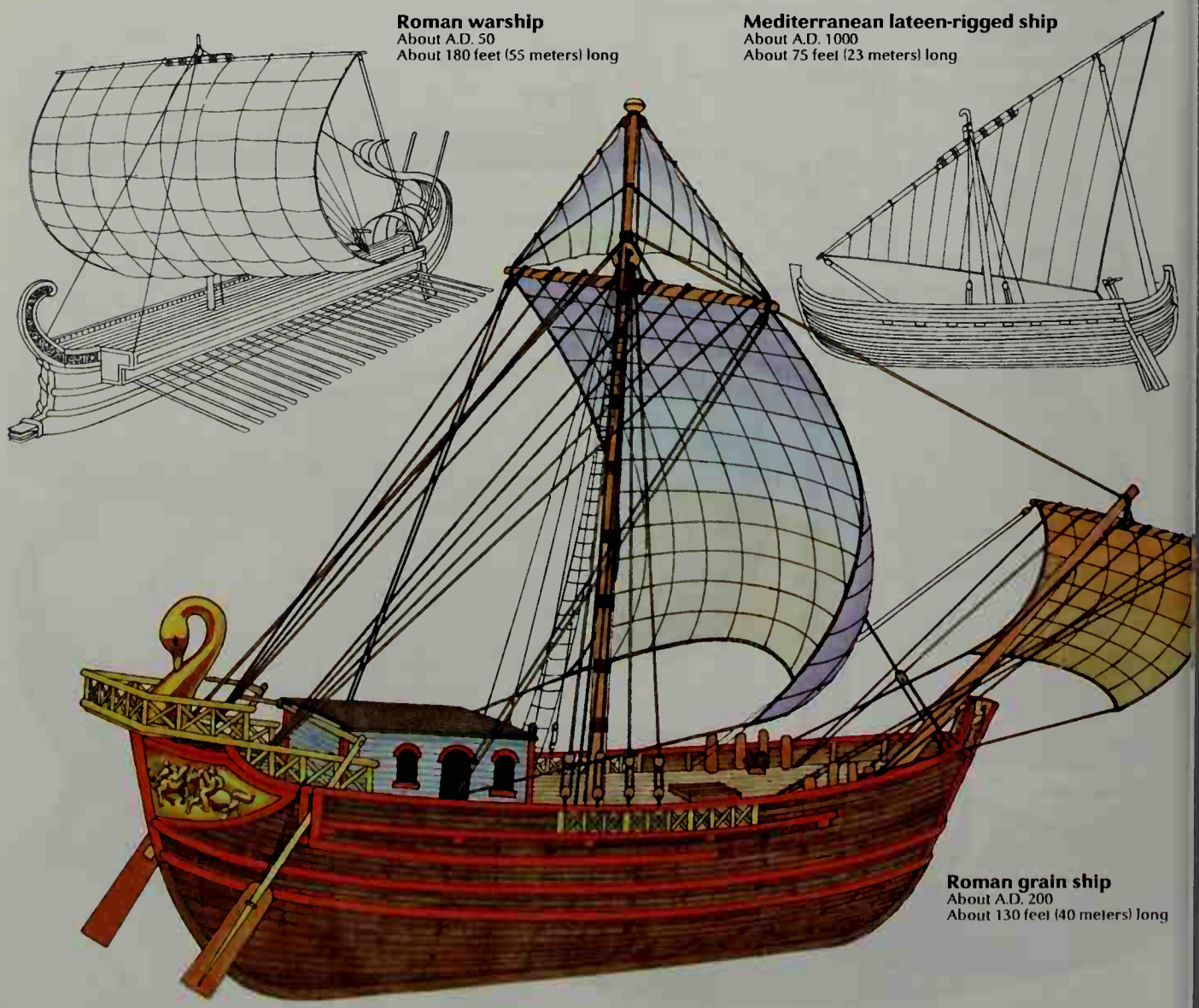
Roman cargo ships, like all freighters of ancient times, carried travelers because no ships were designed only for passengers. Travelers simply reserved space on any freighter going their way. The ships had a few cabins for important people. The other passengers lived on the open deck. These people slept under little shelters that they set up each night.

Viking ships were the best vessels built in northern Europe between the A.D. 700's and the late 1000's. The bold Vikings sailed their famous long ships across the North Atlantic Ocean to Greenland and even to North America. They raided, traded, and colonized. As pirates, they were the terror of the seas.

We know much about the superb Viking ships because many Viking lords arranged to be buried in their boats. Scientists have found several such tombs. A well-preserved example of a Viking warship was uncovered in 1880 near Gokstad, in southeastern Norway. The Vikings built the ship about A.D. 900. It measures 78 feet (24 meters) long and 16 feet 9 inches (5.1 meters) wide. Like all Viking ships, the hull is *clinker-built*—that is, the planks overlap like siding on a house. The ship carried 16 oarsmen on each side. It had a square sail mounted on a mast probably 40 feet (12 meters) high and a steering oar near the stern. The Gokstad ship was small. Most vessels had 20 oars on each side, and some had 30. See **Vikings** (Shipbuilding and navigation).

In 1893, a group of Norwegians built a full-scale replica of the Gokstad ship. They sailed it across the Atlantic Ocean from Bergen, Norway, to St. John's, Nfld., in only 28 days in spite of bad weather.

Roman ships The Romans mainly used the same kinds of warships and cargo vessels that the Greeks had used. But they also had a big, single-banked warship. The Romans built the largest merchant fleet of ancient times. Their biggest cargo ships brought grain from Egypt. The Romans, like the Greeks, used triangular sails called *lateens* on their smaller craft. The big freighters carried square sails. Widespread use of the lateen began in the Mediterranean area during the Middle Ages.



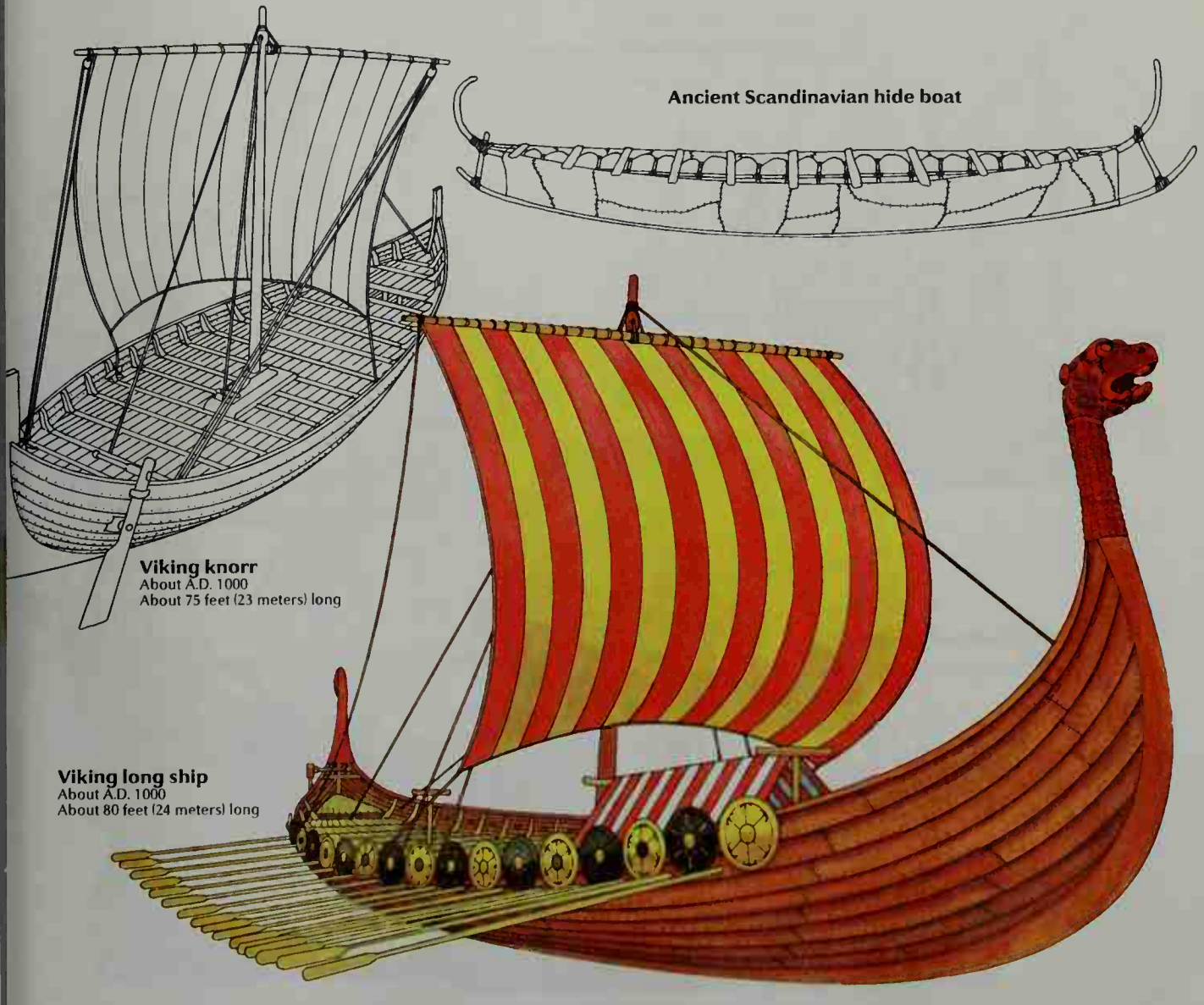
The cog. The power of the Vikings gradually declined. By the late 1000's, they had lost control of the northern seas. Trade then began to increase among the countries of northern Europe. Merchants needed roomier vessels to carry larger shipments. By about 1200, shipbuilders in the north had developed a sturdy ship called the *cog*. It became the standard merchant vessel and warship of northern Europe for about 200 years.

Cogs could stand up against the rough seas and high winds of the North Atlantic Ocean. Their deep, wide clinker-built hulls held bulky cargoes. These ships had one large square sail. They also had a high structure called a *castle* at the prow and the stern. The *forecastle*, at the prow, served as a platform from which marines could fire arrows and stones at enemy ships. The *sterncastle* provided a shelter for important passengers. Cogs also had a new kind of steering apparatus. Instead of steering oars along the sides near the stern, cogs had a large rudder in the middle of the stern. This rudder, introduced by about 1200, was stronger than oars.

Lateen-rigged ships. While northern shipbuilders were developing the cog, Mediterranean shipbuilders were also making important changes in ship construction and design. The Mediterranean shipbuilders began a new way of shipbuilding that became standard. They built a skeleton of keel and ribs first and then fastened the planks of the hull to the framework. They also greatly increased the use of triangular sails called *lateens*. Square sails worked well with winds blowing from behind. But unlike lateen sails, they did not work well when sailing into the wind.

Galleys had always been used in the Mediterranean region as cargo and passenger ships as well as warships. But about 1300, the use of cargo and merchant galleys increased greatly. These galleys generally used their oars only when there was no wind and when entering or leaving a harbor. The rest of the time the vessels were driven by lateen sails. Most galleys had two masts, with the forward mast carrying the large sail. Some had three masts. The merchant galleys were

Viking ships The people of Scandinavia have a long tradition as seafarers. In ancient times, they built dugouts, hide boats, and boats of wooden planks. From these early craft developed the Viking ships—the best ships built in northern Europe between the A.D. 700's and the late 1000's. The Vikings built broad, roomy cargo ships called *knorrs*. But they are best known for their *long ships*. They sailed these swift, narrow vessels across the unknown waters of the Atlantic Ocean to North America.



longer and wider than the warships. The standard galley could carry about 140 short tons (127 metric tons).

The full-rigged ship. About the mid-1400's, Mediterranean shipbuilders combined the best features of the sturdy cog with those of their own lighter lateen-rigged vessels. The result was a sailing ship that became standard throughout Europe for about 300 years. The Mediterranean shipbuilders continued to build the hull by fastening the planking to a skeleton of keel and ribs. But they replaced the steering oars with a rudder in the stern. They also adopted the forecastle and sterncastle of the cog. Most important, they changed the rig to gain more power and better maneuverability—and so developed the full-rigged ship.

The basic full-rigged ship, or *square-rigger,* had a *mainmast* in the middle of the ship, a *foremast* in the forward part, and a *mizzenmast* in the back part. The mainmast and foremast each carried a big square sail and, above it, smaller square sail. The mizzenmast held a lateen sail. A pole that stuck out from the bow carried a small square sail. During the late 1400's and 1500's, such great explorers as Christopher Columbus, Vasco da Gama, Sir Francis Drake, and Ferdinand Magellan used ships rigged in this way.

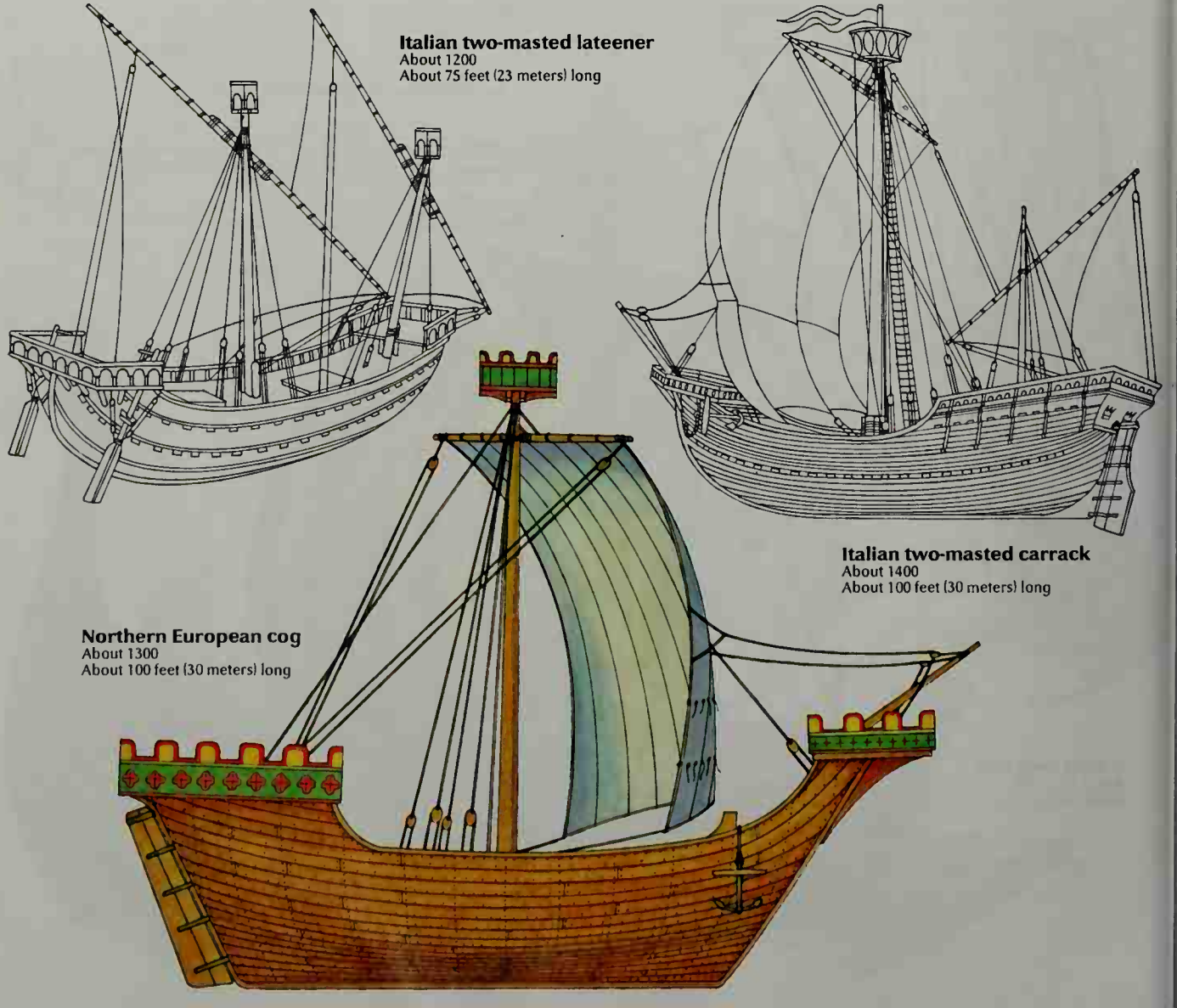
The new three-masted ships were relatively small and had few comforts. Only the captain, other high-ranking officers, and guests had cabins. The rest of the crew slept on the deck or in hammocks below deck. The hammock was an American Indian invention that Columbus brought back to Europe.

The galleon. About the mid-1500's, a type of sailing ship called the *galleon* appeared on the seas. Galleons were big vessels with lower forecastles than other ships and a high sterncastle that housed elaborate living quarters. The forernast and mainmast each carried two or three sails, and the mizzenmast carried one or two. On the biggest galleons, a second mizzenmast was added near the stern.

Galleons served as both warships and cargo vessels. Guns had been used aboard ships since about the mid-

Ships of the 1200's to the 1500's

By about 1200, shipbuilders of northern Europe had developed the *cog*—a one-masted ship with a square sail and high castles at the prow and stern. By about 1200, they invented the rudder. Meanwhile, Mediterranean shipbuilders had increased the use of lateen sails on all their craft, from small boats with one mast to big freighters with three masts. During the 1400's, they combined the best features of the cog and lateener, producing two-masted and, finally, three-masted *carracks.*



1300's. But the galleons carried more and heavier guns. In 1588, the English and Spanish fleets fought one of the most famous sea battles in history. Both sides used galleons. But the English galleons were faster, more maneuverable, and better armed. They helped defeat the Spanish fleet. The Spaniards had called their fleet the *Invincible Armada* because they thought it could not be defeated (see **Spanish Armada**).

Spain, Portugal, and other countries also used galleons for trading. Spain used them to bring back gold and silver from its possessions in the New World. These treasure ships became a favorite target of pirates who roved the Caribbean Sea.

East Indiamen. For centuries, ships had served as both cargo vessels and warships. But by about the 1600's, cannons had become so heavy that ships needed specially built hulls to carry the added weight. The design of warships and unarmed cargo vessels thus became, in time, greatly different.

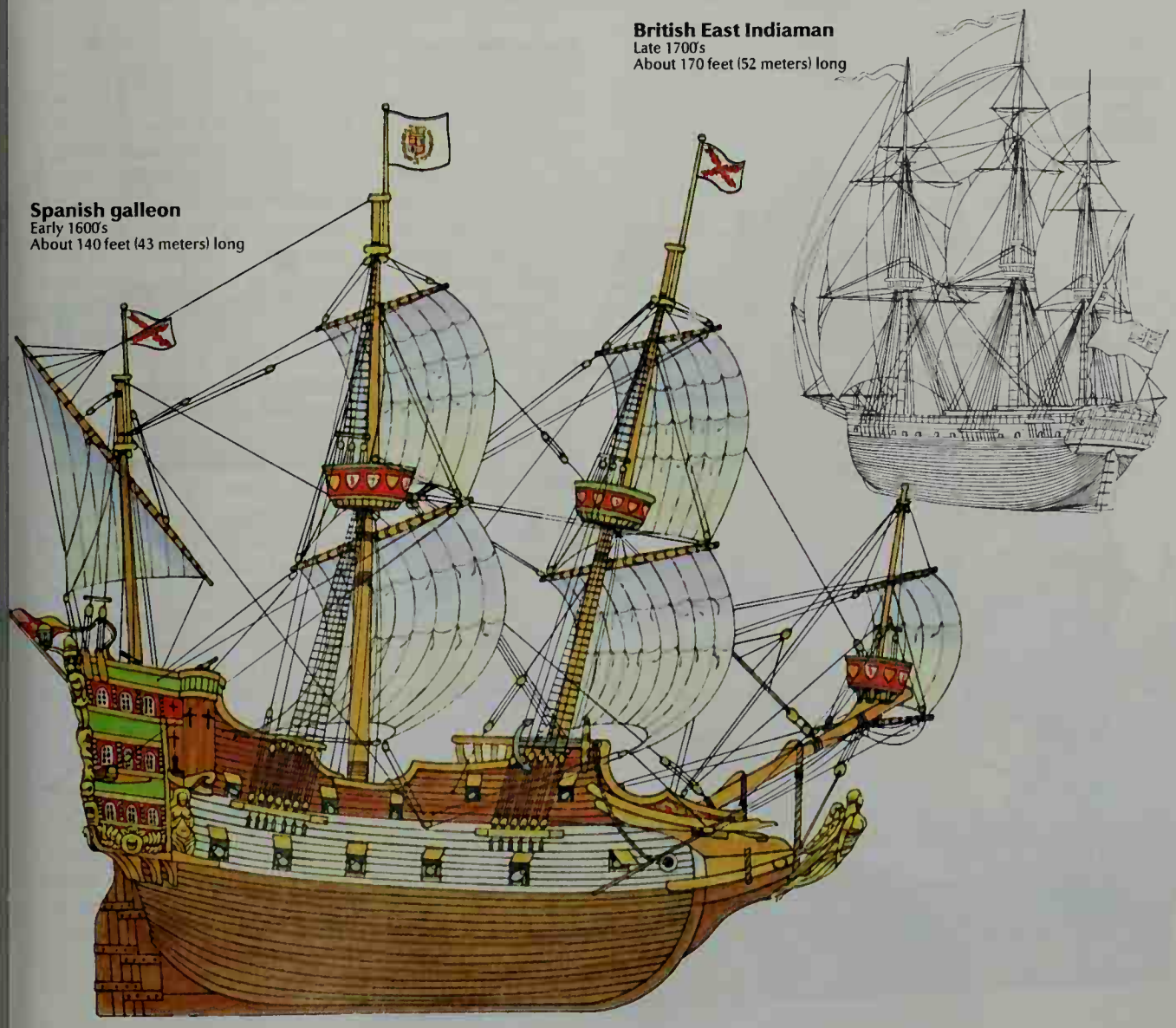
In the 1600's, trading companies in several European countries began to build merchant ships especially for trade with India and the Far East. These ships brought ivory, silks, spices, and other products from India, China, and the East Indies. The Portuguese controlled the trade with the Far East until about 1600, when England and the Netherlands began to compete. Then Denmark and France also moved in. East India companies in each country built their own ships, called *East Indiamen*. Although the Indiamen were designed as cargo carriers, they carried guns for defense against attacks by pirates and fleets of enemy countries.

The size of the East Indiamen grew steadily larger. In 1700, for example, most English Indiamen carried 400 short tons (360 metric tons) of cargo. By 1800, they carried 1,200 short tons (1,090 metric tons).

Packet ships. By the early 1800's, trade between the United States and European countries had increased tremendously. Also, a great demand had developed for better transatlantic passenger service. American shipowners met the demand by offering something new in

Ships of the 1500's to the 1800's

Galleons appeared on the seas about the mid-1500's. These big ships had high sterncastles and two or three sails on the foremast and mainmast and one or two sails on the mizzenmast. Galleons served as both warships and merchant ships. During the 1600's, European trading companies began to build large ships called *East Indiamen* for the rich trade with India and the Far East. These ships carried guns for defense against attacks by pirates and fleets of enemy countries.



service—ships that sailed on regular schedules. Such vessels are called *packet* ships. Before this time, ships sailed only if they had a full load of cargo and passengers. Also, the weather generally had to be favorable. Packet ships sailed at a scheduled time, fully loaded or not and regardless of the weather. The packets also became the first merchant vessels to stress the comfort of passengers. Packet service began in 1818, between New York City and Liverpool. The Black Ball Line started the service. It was so successful that other U.S. lines, such as Red Star and Swallowtail, quickly followed.

To meet the schedules and the competition, the packet ships had to sail as fast as possible. But the ships themselves were ordinary sailing vessels that had not been designed with especially sharp lines for speed. Their speed came from their captains, who drove the ships furiously night and day in all weather. The eastward crossing took from three to four weeks. The westward crossing took longer—from five to six weeks—because the ships had to sail against the westerly winds and took a longer, more southerly route.

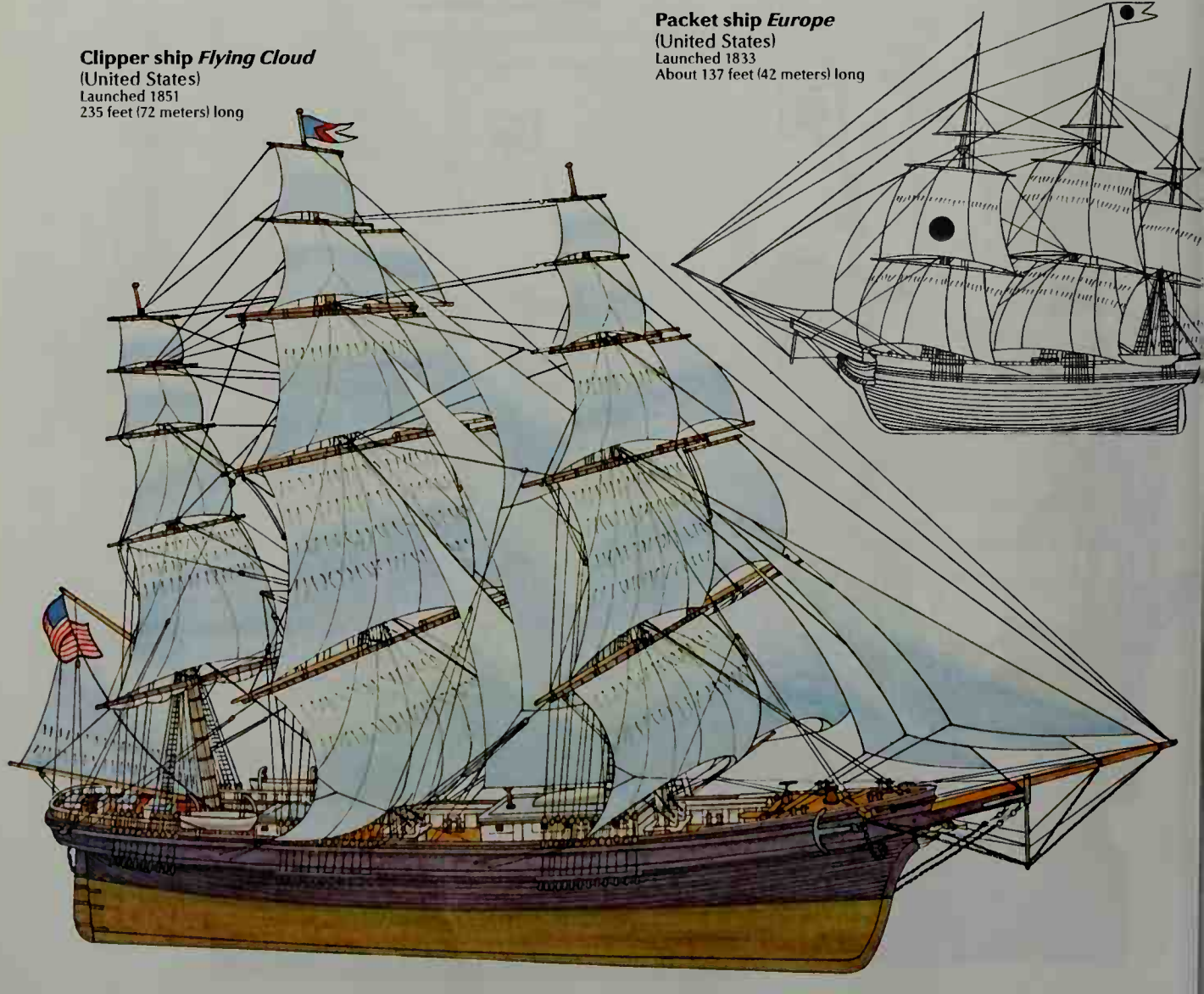
The first packets measured about 100 feet (30 meters) long. By the 1840's, as passenger accommodations became larger and more comfortable, ships 160 feet (49 meters) long had come into use.

Clipper ships, the most beautiful and romantic of all sailing ships, became the queens of the seas during the mid-1800's. The clippers, with their slender hulls and many sails, were designed for speed. Their name came from the way the ships "clipped off" the miles.

The United States built the first true clippers in the 1840's. They were designed to sail from the East Coast, around the tip of South America, to China and bring back tea. The discovery of gold in California in 1848 and in Australia in 1851 hastened the clipper's development as fortune seekers and supplies were rushed to the gold fields. The ship's success led the British to build a fleet to carry tea from China and wool from Australia.

Clippers had as many as six *tiers* (rows) of sails to a mast. Some ships had as many as 35 sails. Driven at top

Ships of the 1800's The most famous ships of the 1800's included the *packets* and *clippers*. Packet ships began to cross the Atlantic Ocean in 1818. They sailed on regular schedules whether or not they were fully loaded. Clipper ships appeared during the 1840's. They brought tea from China and wool from Australia and carried passengers around Cape Horn to California during the gold rush of 1849-1857. Clippers, with their many sails and slender hulls, could speed through the water.



speed, clippers could cut through the water at 20 knots. Many could race from New York City, around South America, to San Francisco in less than 100 days.

Donald McKay, a Canadian, became the greatest designer of clipper ships. His shipyard in East Boston, Massachusetts, turned out a number of them. McKay's first clippers measured about 200 feet (60 meters) long and could carry 1,500 tons (1,360 metric tons). He steadily increased the size of his ships. In 1853, he launched the *Great Republic,* which was the largest sailing ship of its time. It was about 335 feet (102 meters) long, had four masts, and could carry more than 4,500 tons (4,080 metric tons).

Sailing ships in the 1900's. Inventors began experimenting with steam-powered boats in the late 1700's. By the early 1900's, the steamship had nearly replaced the oceangoing sailing ship. But coal-burning steamships had to depend on coaling depots, and certain trade routes—such as those along the coasts of South America—had few coaling depots. On these routes, sailing ships still had use. For many years, for example, sailing ships carried *nitrate,* a fertilizer, from Chile, around the tip of South America, to Europe.

The sailing ships launched during the late 1800's and early 1900's were huge vessels built more for strength than speed. They had strong, straight-sided steel hulls and wire rigging. To operate cheaply, they used small crews and, therefore, carried a minimum amount of sail. The mightiest of these ships was the *Preussen,* a five-masted, full-rigged German vessel built in 1902. It was the largest sailing ship ever built, measuring 433 feet (132 meters) long and 54 feet (16 meters) wide. It could carry 8,000 tons (7,300 metric tons) of cargo.

Since the early 1900's, the number of seagoing sailing ships has declined steadily. Many have rotted or rusted away at their docks. Today, most of the few remaining square-riggers serve as training ships for cadets in the navies and merchant marines of various countries.

In many developing countries, people still use sailing vessels for coastal and inland shipping and for fishing. Many centuries ago, the Chinese developed the *junk,* a sturdy wooden vessel that carried its sails parallel to the length of the ship. The Chinese still use junks to carry goods and passengers along coasts and on rivers. For hundreds of years, the Arabs have sailed the Red Sea in long, slim, lateen-rigged vessels called *dhows.* Various Indian versions of the dhow are common in the harbors of Kolkata, Mumbai, and other port cities of India. The people of New Guinea have long used a sailing vessel called a *lakatoi,* which consists of several dugouts lashed together. Two-masted sailing ships called *schooners* carry cargo along the eastern and southern shores of the Mediterranean. Schooners and single-masted *sloops* sail between Panama and Ecuador and along South America's west coast.

The age of engine-powered ships

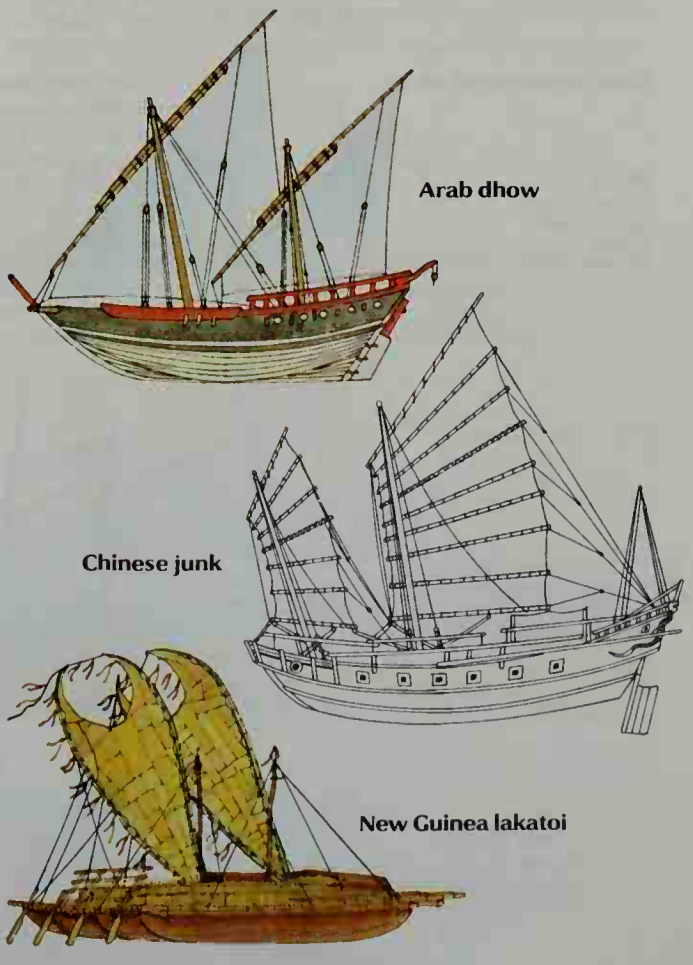
The invention and development of the steam engine revolutionized water transportation. People no longer had to depend on the muscles of rowers or the uncertain wind to propel their ships. In 1769, James Watt, a Scottish engineer, patented a steam engine that could do many kinds of work. Inventors in Europe and the United States soon tried to use it to power boats.

The first steamboats. In 1783, the Marquis Claude de Jouffroy d'Abbans, a French nobleman, built a steamboat that made a 15-minute trip on the Saône River near Lyon. But the marquis was never able to repeat his success. In 1787, John Fitch, an American inventor, demonstrated the first workable steamboat in the United States. Its engine powered a series of paddles on each side of the boat. Fitch later developed a vessel pushed by paddles at the stern. With this boat, he started the nation's first commercial passenger and freight service during the summer of 1790. He navigated the boat on schedule up and down the Delaware River between Philadelphia, Pennsylvania, and Trenton, New Jersey. But Fitch lacked enough money to keep operating. In 1802, William Symington, a British engineer, built a steam tug that had a paddle wheel at the stern. The tug worked perfectly, but Symington also ran out of money.

The *Clermont* became the first commercially successful steamboat. Robert Fulton, an American, designed and built the vessel, which was officially called the *North River Steam Boat.* Fulton did not try to con-

Sailing ships of the 1900's

Few seagoing sailing ships are used today. But in many developing countries, people still use them for coastal and inland shipping and for fishing. These ships include the lateen-rigged *dhow* of Arabia, the wooden *junk* of China, and the *lakatoi* of New Guinea, known for its sails shaped like crab claws.



struct an engine himself, as earlier inventors had done. Instead, he ordered one from Watt and adapted it to his boat. In 1807, the *Clermont* steamed 150 miles (241 kilometers) up the Hudson River from New York City to Albany in about 30 hours, including an overnight stop. After extensive rebuilding, the boat sailed in regular passenger service on the Hudson. The *Clermont* was long and slender—originally 142 feet (43 meters) long and 14 feet (4.3 meters) wide. It had side paddle wheels 4 feet (1.2 meters) wide and 15 feet (4.6 meters) in diameter. After the rebuilding, the *Clermont* was 149 feet (45.4 meters) long and 18 feet (5.5 meters) wide.

Oceangoing steamships. Fulton's boats puffed along only on bays and rivers. In 1809, the *Phoenix* became the first steamboat to make an ocean voyage. John Stevens, an American engineer, built it. The *Phoenix* traveled along the Atlantic Coast and up the Delaware River from New York City to Philadelphia. The trip took 13 days. Under perfect conditions, sailboats could do it in 2 days. In 1819, an American vessel, the *Savannah,* became the first steamship to cross the Atlantic Ocean. It was actually a full-rigged sailing ship equipped with steam-powered side paddle wheels. The ship took 29 days to travel from New York City to Liverpool. During the voyage, it ran its engine 105 hours, using up its entire fuel supply of 75 short tons (68 metric tons) of coal and 25 cords (91 cubic meters) of wood. In 1838, the British side-wheeler *Sirius* became the first ship to offer regularly scheduled service across the Atlantic under steam power alone. The trip took 18½ days.

Ships of iron. During the late 1700's, British shipbuilders had begun to construct iron vessels, partly because good wood for ships was becoming scarce in Great Britain. But iron ships also had many advantages over wooden ones. They were stronger, safer, more economical, and easier to repair. In addition, iron ships were lighter than wooden ships of the same size, because wooden ships required huge, heavy timbers. As a result, iron ships could hold more cargo.

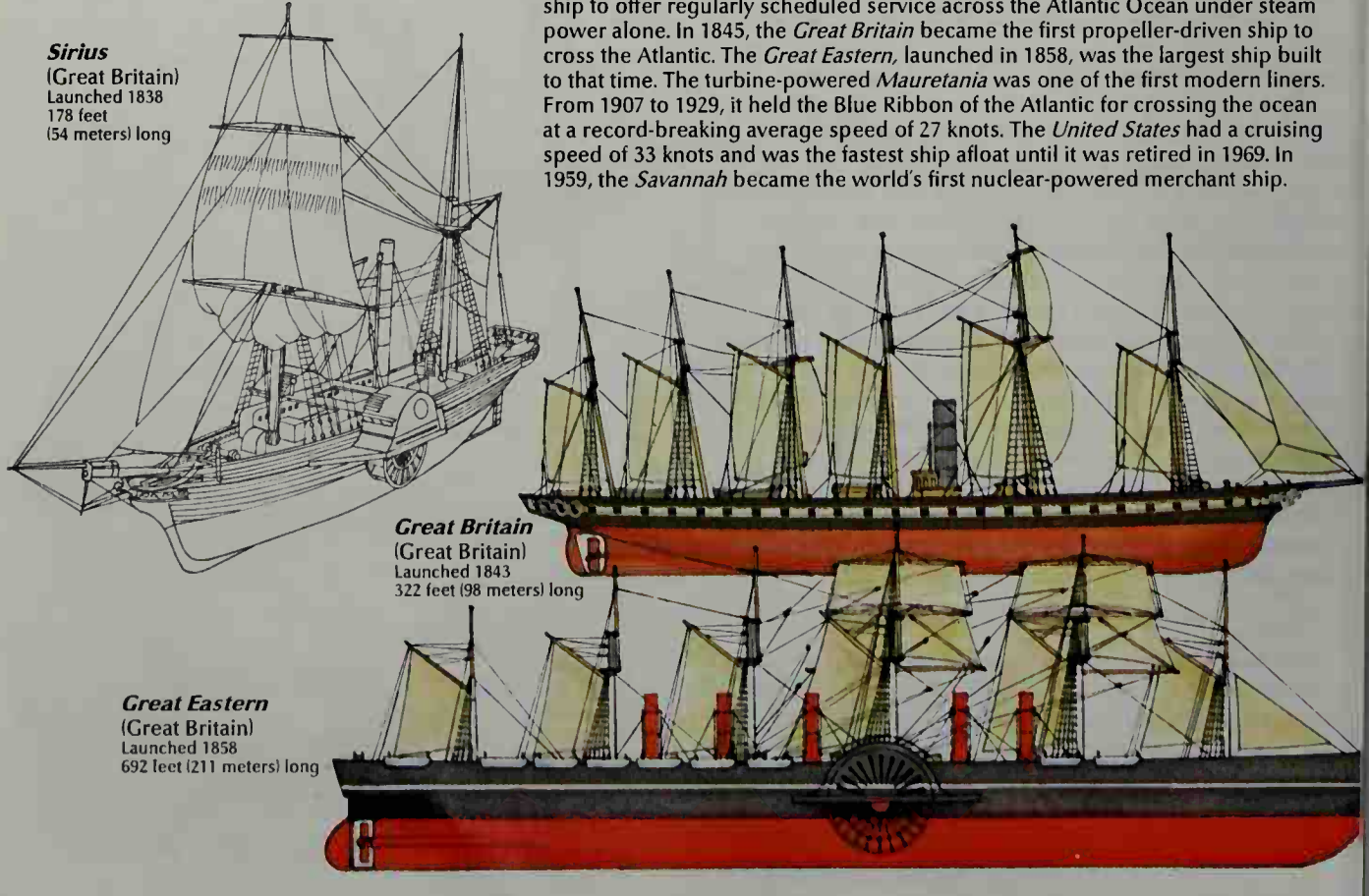
Great Britain led the world in the development of iron seagoing ships. In 1821, it launched the *Aaron Manby,* probably the first all-iron steamship. Britain's most gifted naval architect of the mid-1800's was Isambard Kingdom Brunel. In 1837, he launched the *Great Western,* the first steamship designed especially for regular Atlantic crossings. The *Great Western* measured 236 feet (72 meters) long and 35 feet (11 meters) wide. Its huge side wheels drove the vessel at 9 knots. Brunel designed ever-larger ships. In 1858, he completed the *Great Eastern,* the most spectacular ship built to that time. It was 692 feet (211 meters) long and about 85 feet (26 meters) wide and accommodated 4,000 passengers. But the ship failed economically. It did not attract enough customers to pay the huge operating costs. The *Great Eastern* was used in laying four successful transatlantic telegraph cables across the ocean floor. In 1888, the ship was sold for scrap.

During the late 1800's, steel began to replace iron for ships. Steel ships were stronger and lighter than iron ones. In 1881, the *Servia,* a British vessel, became the first all-steel passenger liner to cross the Atlantic.

Development of the ship propeller. In 1836, two inventors—Francis Pettit Smith of England and John Ericsson of Sweden—each patented a propeller that

Engine-powered ships

Each vessel shown below and on the next page made history in the development of engine-powered ships. In 1838, the *Sirius,* a side-wheeler, became the first ship to offer regularly scheduled service across the Atlantic Ocean under steam power alone. In 1845, the *Great Britain* became the first propeller-driven ship to cross the Atlantic. The *Great Eastern,* launched in 1858, was the largest ship built to that time. The turbine-powered *Mauretania* was one of the first modern liners. From 1907 to 1929, it held the Blue Ribbon of the Atlantic for crossing the ocean at a record-breaking average speed of 27 knots. The *United States* had a cruising speed of 33 knots and was the fastest ship afloat until it was retired in 1969. In 1959, the *Savannah* became the world's first nuclear-powered merchant ship.



could drive steamboats more efficiently than paddle wheels could. The side paddles had worked well in calm waters. But in rough seas, as a ship rocked from side to side, one wheel and then the other might stick completely out of the water, wasting power. In addition, waves easily damaged the fragile wheels. A ship propeller, wholly under the water at the stern, used power more efficiently than the paddle wheels did. As the propeller bit into the water, it also pushed the ship forward much faster. In 1845, the *Great Britain,* designed by Brunel, became the first propeller-driven ship to travel across the Atlantic.

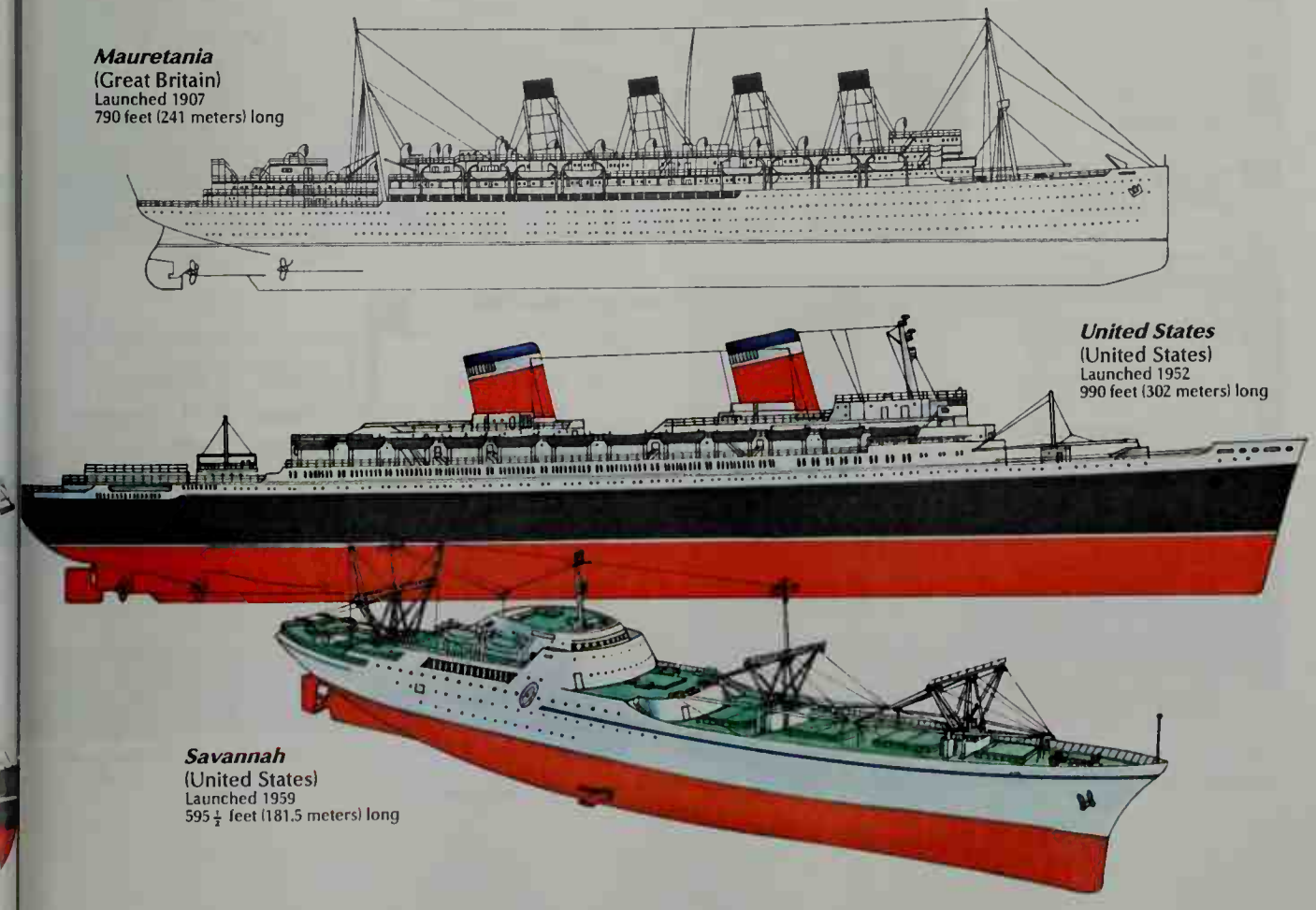
Increasing power and speed. New types of engines and new sources of power were developed as ships changed from wood to steel and from paddle wheels to propellers. Until the middle to late 1800's, ships used a one-cylinder steam engine. The steam expanded in the cylinder, drove the piston a full stroke, and then passed to a condenser, where it was converted back to water. By the late 1800's, the *compound* steam engine, which had two cylinders, began to be used on ships. In the compound engine, steam pushed the piston in one cylinder and then passed on to a second, larger cylinder. The engine thus created much more power from the same amount of steam. The compound steam engine cut the use of coal on ships up to 50 per cent. Later, shipbuilders installed three-, four-, and five-cylinder steam engines on their ships.

In the 1890's, Charles A. Parsons, an English engineer, designed a marine *steam turbine,* a completely new type of marine engine. It was much more powerful and efficient than the steam engine. In 1897, Parsons installed three turbines in his vessel, the *Turbinia.* The turbines powered the vessel at an amazing 34½ knots. Within a few years, fast luxury liners began crossing the Atlantic Ocean powered by steam turbines. One of the most famous of these liners was the British ship *Mauretania,* launched in 1907. It was 790 feet (241 meters) long and had a speed of 27 knots.

While Parsons was working on his steam turbine during the 1890's, Rudolf Diesel, a German mechanical engineer, was perfecting another new type of engine. It used heavy oil as fuel. His engine, now called the *diesel engine,* used less fuel than the turbine and required much less space on a ship. In 1910 and 1911, the first diesel-powered ships, which are called *motorships,* went into operation. Beginning about 1920, oil also began to replace coal as fuel for steam turbines. Today, most steamships use oil.

Nuclear power and automation. In 1954, the United States launched the world's first nuclear-powered ship, the submarine *Nautilus.* It was retired in 1979. In 1959, the U.S. launched the *Savannah,* the first nuclear-powered merchant ship. It was retired in 1971. Germany, Japan, and the Soviet Union also built nuclear-powered merchant ships. But nuclear merchant vessels are still impractical for commercial use because of their high building and operating costs.

Ships today have become increasingly automated. On many modern vessels, for example, electronic equipment controls the flow of fuel oil and air to the furnace and of water to the boilers. Automatic navigation aids help keep ships on course. Ships have also become larger and larger, and entirely new types have been developed. The next section of this article discusses the kinds of ships used today and tells how they developed.



Ships of today

Until the late 1940's, the queens of the sea were the great oceangoing passenger liners. France, Germany, and Great Britain built most of these magnificent floating hotels. The liners stressed luxury and service. In addition to the regular deck and engine room hands, an army of cabin and dining room stewards, cooks and bakers, and other service workers staffed the liners.

Beginning in the late 1940's, airplanes began to carry more and more people across the seas. Today, relatively few passenger liners sail the oceans, and the great cargo ships have become the queens of the sea. These ships emphasize efficiency and economy.

Cargo vessels have become bigger and bigger, chiefly for economic reasons. For example, shippers have found it far cheaper to transport 100,000 short tons (91,000 metric tons) of oil in one huge tanker than in five smaller ones carrying 20,000 short tons (18,000 metric tons) each. Also, for economic reasons, shipbuilders have designed vessels that can be loaded and unloaded in a minimum amount of time with minimum labor. In addition, more and more cargo ships are being automated so they can be run by smaller and smaller crews.

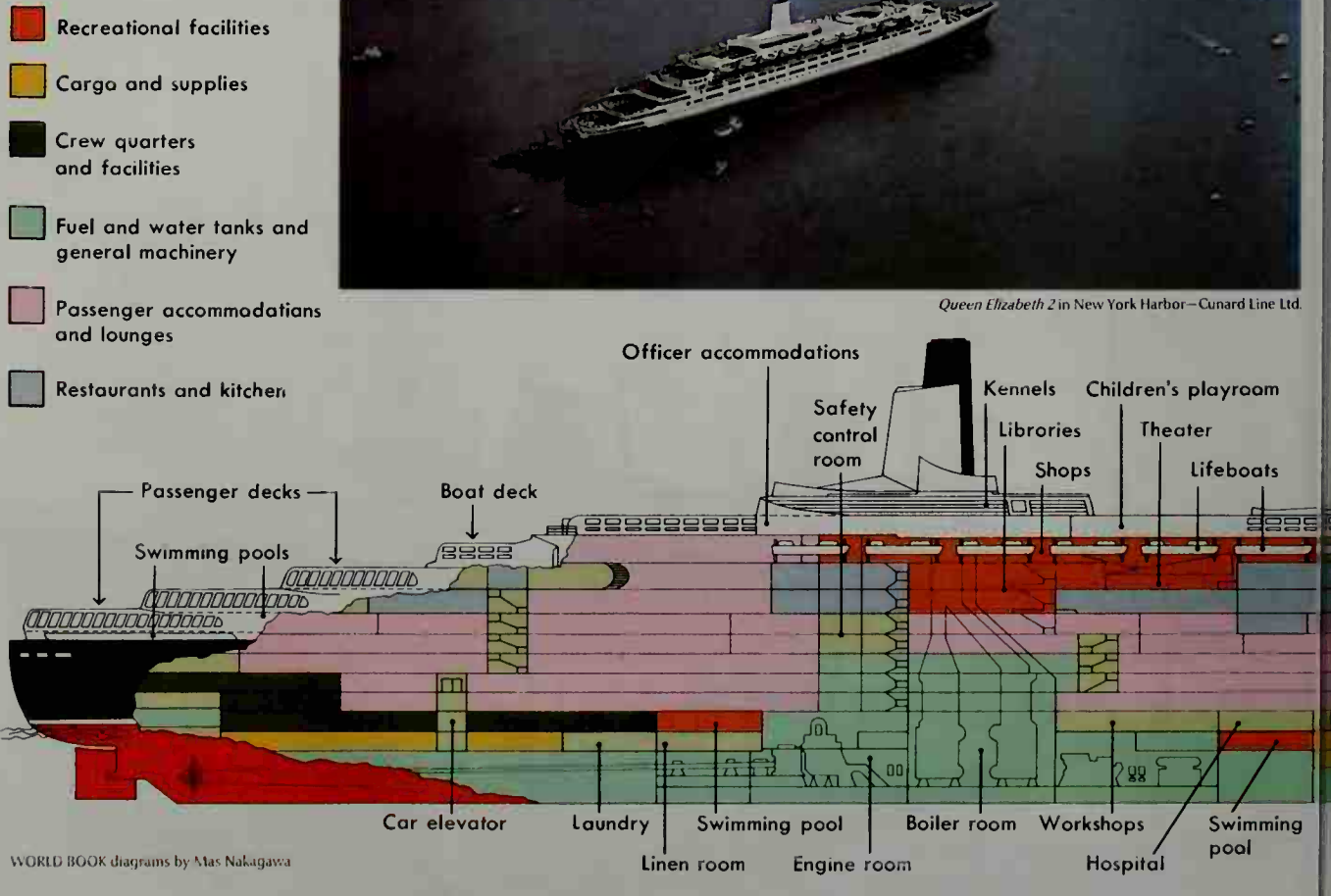
Passenger vessels

The sailing packets that began to cross the Atlantic Ocean in the early 1800's were the first ships to stress

The *Queen Elizabeth 2*

The *Queen Elizabeth 2* is one of the largest and most modern passenger ships. The British liner is 963 feet (294 meters) long. It was launched in 1967 and made its maiden voyage in 1969. It can carry over 1,700 passengers and has a crew of 1,000. The ship has a cruising speed of 32½ knots. The *Elizabeth* makes regular transatlantic crossings from April to December. In winter, it carries vacationers on a cruise around the world. The diagram below shows a cross section of the ship.

Queen Elizabeth 2 in New York Harbor—Cunard Line Ltd.



WORLD BOOK diagrams by Mas Nakagawa

passenger comfort. From then on, shipping companies provided better and better passenger services. As ships switched from sails to steam power during the 1800's, British companies offered the best accommodations, largely because of Brunel's excellently designed ships.

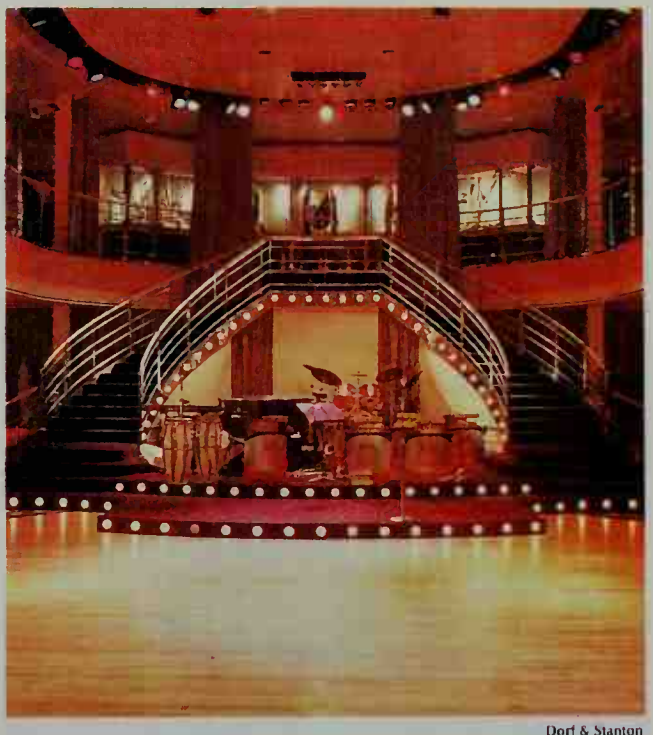
Two British firms—the Cunard Line and the White Star Line—dominated transatlantic service until about 1900. Then, Germany's North German Lloyd Line and Hamburg American Line began to offer serious competition. Later, French and Dutch lines entered the race for transatlantic passenger business. Much of this business came from transporting immigrants from the Old World to the New World. The United States took the lead in providing service across the Pacific Ocean with the founding of the Pacific Mail Steamship Company in 1848. As various shipping lines competed for passengers, ships became larger, faster, and more luxurious.

Ocean liners. The great age of the ocean liner came in the early 1900's. It reached its height in the 1930's with the launching of three of the most luxurious ships ever built. They were the *Normandie* of France and the *Queen Mary* and *Queen Elizabeth* of Britain. These giants, each almost 1,000 feet (300 meters) long, crossed the Atlantic Ocean in just over four days. In 1942, a fire destroyed the *Normandie* as it lay in New York Harbor.

Beginning in the late 1940's, the airplane began to

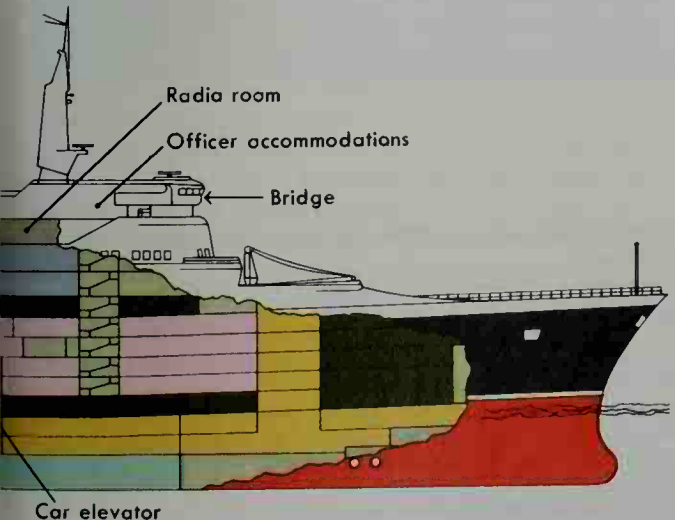
Dorf & Stanton

The elegant *Queen's Grill* is one of four gourmet restaurants on the *Elizabeth.* World-class chefs and a staff of over 200 waiters and about 140 kitchen personnel serve the dining rooms.



Dorf & Stanton

The *Grand Lounge* is one of the features added when the *Elizabeth* was renovated in 1986 and 1987. The lounge includes a dance floor, a bandstand, and a shopping promenade.

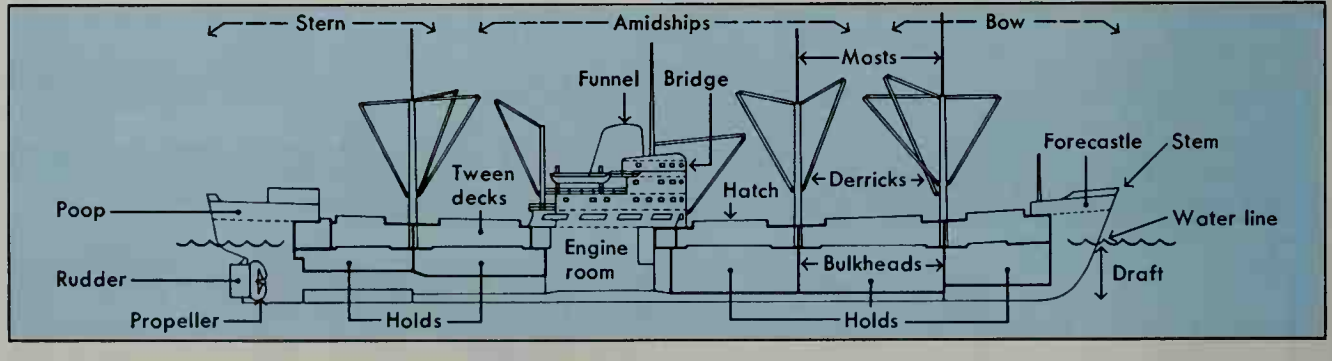


Dorf & Stanton

Passenger accommodations on the *Queen Elizabeth 2* consist of standard-class rooms, deluxe-class rooms, *above,* and luxury suites. All rooms are air-conditioned.

Nautical terms

Abaft means to the rear of. For example, abaft the mainmast means to the rear of the mainmast.
Aft means toward, at, or near the stern. To go aft is to go toward the stern.
Amidships means in the middle part of a ship, halfway between the bow and stern.
Ballast is the seawater or any other heavy substance carried in the deepest holds to help keep the ship stable.
Beam is the width of a ship at its widest point.
Below means under the main deck. To go below means to leave the main deck and go anywhere beneath it.
Binnacle is the stand that holds a ship's compass.
Bow is the front part of a ship.
Bridge is the elevated platform above the main deck from which a ship is navigated.
Bulkheads are walls that divide a ship into compartments.
Bulwarks are low metal walls built around the main and upper decks. Bulwarks help prevent waves from breaking over the decks. They also help keep people or objects from falling or being washed overboard.
Companionway refers to a stairway between decks.
Crow's-nest is a small platform high on a mast from which a crew member keeps lookout.
Derricks are lifting devices that lower cargo into or hoist it out of the holds.
Draft is the depth of a ship in the water—the distance from the water line to the bottom of the keel.
Forecastle (pronounced *FOHK suhl*) is a raised deck near the bow. The term also refers to the crew's quarters in the forward part of a ship.
Forward means toward the front of a ship.
Freeboard is the distance between the water line and the main deck.
Funnel is the smokestack of a ship.
Hatch is an opening in the deck through which cargo is lowered into or hoisted out of a hold. A *hatch cover* fits over the hatch and keeps water from going below.
Helm is a ship's steering wheel.
Holds are areas below deck in which cargo is stored.
Keel is the backbone of a ship. It is a ridge that runs along the lowest part of the hull from the stem to the stern.
Lee side is the side of a ship away from the wind.
Moor means to keep a ship in place with ropes tied to a pier, to a buoy attached to an anchor, or to another ship.
Poop is a short raised deck at the rear of a ship.
Port is the left side of a ship when facing toward the bow.
Quarter refers to a section on each side of a ship near the stern.
Ship's bell signals the time aboard ship. On most ships, a day consists of six 4-hour *watches* (periods when crew members stand duty). The officers and crew have eight hours off duty after each watch. The watches change at 8 a.m., noon, 4 p.m., 8 p.m., midnight, and 4 a.m. Some ships have two two-hour watches called *dogwatches* each day, one from 4 to 6 p.m. and the other from 6 to 8 p.m. A chime marks each half-hour. During a four-hour watch, one bell chimes at the first half-hour, two bells at the second, and so on up to eight. At the eighth half-hour chime, the next watch begins and the sequence starts over again.
Starboard is the right side of a ship when facing the bow.
Stem is the foremost part of a ship.
Stern is the rear part of a ship.
Superstructure consists of all the structures on a ship that rise above the main deck.
Tween decks are spaces above the holds of general cargo ships in which additional cargo may be stored.
Water line is the point on the hull that the surface of the water reaches.
Windward side is the side of a ship from which the wind is blowing.



Nautical measurements

Deadweight tonnage is a ship's actual carrying capacity measured in long tons. A long ton equals 2,240 pounds (1,016 kilograms, or 1.016 metric tons). Deadweight tonnage includes cargo, crew, passengers, fuel, supplies, and spare parts. Freighters and tankers are generally described in terms of deadweight tonnage.
Displacement tonnage is the number of long tons of water *displaced* (occupied) by a ship. This measurement is generally used for naval craft.
Gross tonnage is the amount of a ship's enclosed space. It is a measure of volume, not weight, and is expressed in units of 100 cubic feet (2.8 cubic meters). A ship of 5,000 gross tons has 500,000 cubic feet (14,158 cubic meters) of enclosed space. Passenger ships are usually measured in terms of gross tonnage.
Knot means one *nautical mile per hour*. A ship's speed is measured in knots. A nautical mile equals 6,076 feet (1,852 meters), and a land mile equals 5,280 feet (1,609 meters). Therefore, a ship that does 10 knots travels somewhat faster than 10 miles (16 kilometers) per hour. See Knot.
Net tonnage is the amount of revenue-producing space of a ship. The net tonnage of a ship is found by subtracting the engine room, the quarters of the crew, and all other areas on the ship that do not hold cargo from the gross tonnage. Net tonnage is used to determine harbor fees, taxes, and canal tolls.

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Air cushion vehicles ride on air just above the water's surface. They move rapidly over short distances. The Canadian Coast Guard uses these craft as rescue vehicles, as shown here.

attract more and more transoceanic passengers. Today, jet planes fly daily between the world's great cities. They cross the sea in hours, not days, and at about half the cost of an ocean trip. Most ocean liners cannot compete with the airplane and have given up. During the 1960's, the United Kingdom sold the *Queen Mary* and *Queen Elizabeth* to American investors who planned to make tourist attractions of the ships. In 1972, fire destroyed the *Queen Elizabeth* as it lay at anchor in Hong Kong Harbor. The *Queen Mary* became a hotel docked at Long Beach, California. In 1951, American shipbuilders launched the *United States,* the pride of the nation's passenger fleet. The *United States* had a cruising speed of 33 knots and was the fastest ocean liner afloat. But in 1969, the ship stopped operating because of a lack of passengers. Today, the United States has no major passenger liner service across the Atlantic.

Today, the only luxury liner to make transatlantic crossings is the United Kingdom's *Queen Elizabeth 2,* which was launched in 1967. It crosses the Atlantic from spring to fall, and it carries passengers on a cruise around the world during the winter months. Most liners today are used as cruise ships to the Mediterranean, the Caribbean, and other vacation areas. The *Voyager of the Seas,* a cruise ship that began service in 1999, can carry more passengers than any other ship. The *Voyager* can accommodate 3,100 passengers.

Other passenger vessels. Although the airplane has largely replaced the ocean liner for transoceanic travel, vessels for carrying passengers short distances over water have become increasingly important. Such short-distance vessels include car ferries, hydrofoils, and air cushion vehicles.

Car ferries have carried automobiles, passengers, and even railroad passenger cars across harbors, lakes, rivers, and other small bodies of water for many years. Like cargo ships, ferries have become bigger and bigger. Today, the biggest ones cross such large bodies of water as the Adriatic and Baltic seas and the English Channel. The largest car ferries can hold up to 800 passengers and 360 cars. They have dining rooms, lounges, and bars. Some ferries make overnight runs and have cabins for most passengers.

Hydrofoils provide high-speed transportation over relatively short distances. These vessels are mounted on *foils* (wings that skim near the surface of the water). The hull remains completely out of the water, greatly reducing the drag caused by water resistance. Hydrofoils can reach speeds greater than 80 knots. These vessels have carried passengers across New York Harbor, on the Nile River of Egypt, across the Strait of Messina in Italy, and over other bodies of water in many parts of the world.

Air cushion vehicles also provide fast trips for short distances. Such vehicles are also called *hovercraft* or *ground effect machines.* Air cushion vehicles have a powerful horizontal fan that produces a strong, continuous thrust of air between the vehicle and the water or ground beneath it. The craft, which is driven by airplane-style propellers, rides on this cushion of air and can do almost 70 knots. Air cushion vehicles are especially popular in the United Kingdom, where they have carried passengers on the River Thames, along the coasts, and across the English Channel to France.

Classification of cargo ships

Cargo ships, or freighters, can be divided into four groups, according to the kind of cargo they carry. These groups are (1) general cargo ships, (2) tankers, (3) dry bulk carriers, and (4) multipurpose ships. *General cargo ships* carry what are called "packaged" items—goods that are put in packages or that form a package in themselves. Packaged items include such products as chemicals, foods, furniture, machinery, motor vehicles, shoes, steel, textiles, and whiskey. *Tankers* carry petroleum or other liquid cargo. *Dry bulk carriers* haul coal, grain, iron ore, and similar products that can be loaded *in bulk* (loose) on the vessels. *Multipurpose ships* carry different classes of cargo—for example, liquid and general cargo—at the same time.

Cargo ships can also be divided into two types according to the service they offer shippers—*liner service* or *tramp service.* Cargo liners run on fixed schedules along certain trade routes and charge published rates. They usually transport only general cargo. Some cargo liners also carry passengers. Those that carry more than 12 passengers are called *combination* or *passenger-cargo* ships. These vessels must meet safety standards set up for passenger ships. Large shipping companies operate cargo liners. Tramp ships do not sail on regular trade routes or have regular schedules. They wander the sea lanes like taxicabs and can be hired to haul almost anything, anywhere, anytime. Small shipping companies and private individuals operate these ships.

General cargo ships

During the early 1900's, the standard general cargo ship was a *three-island* ship. Its name came from three structures that stood out above the main deck like separate islands. The forecastle, which held the crew's quarters, formed one island at the bow. The bridge, from

which the ship was navigated, formed the second island in the middle of the ship. The engine room was below the bridge. The poop, which held cabins for the officers and passengers, formed the third island at the stern. Hatches between the islands led to the holds beneath the deck where the cargo was stored. Each hold was a separate area with a hatch cover over it. The *derricks* (lifting devices) that loaded and unloaded each hold rose alongside the hatches.

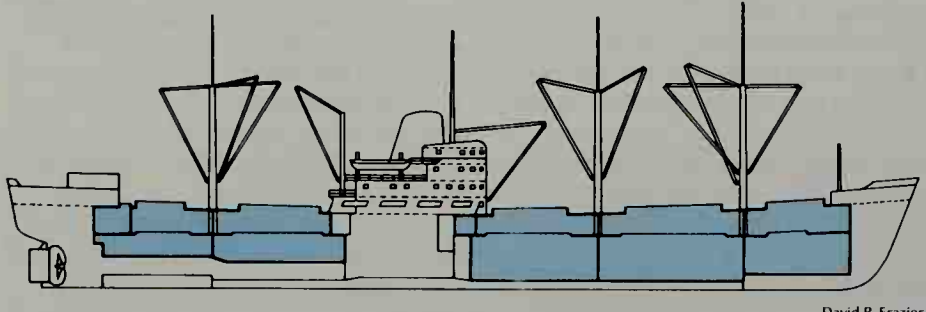
In time, the three-island ships gave way to freighters with one island, either in the middle of the ship or toward the stern. The island included the bridge and living quarters, with the engine room below. The one-island ship provided room for more and bigger hatches and so made it easier to load and unload cargo. During World War II (1939-1945), shipyards in the United States built more than 3,000 one-island ships—the famous Liberty and Victory ships. Both types of ships were about the same size, but the Victory ships, powered by steam turbines, were faster. The Liberty ships had reciprocating steam engines (see **Steam engine** [Reciprocating steam engines]). Both ships were built according to standard plans so they could be mass-produced. They carried millions of troops and millions of tons of supplies to battlefields in every part of the world.

Traditional cargo ships. Since World War II, the traditional general cargo ship has steadily become more advanced. Today, it has powerful, electrically driven cranes and derricks. It can be loaded at the side and stern as well as at the hatches. It has automatic engine room controls and automatic navigation equipment. Yet the traditional general cargo ship has steadily been declining in use, chiefly because of high operating costs. A typical ship may carry automobiles, sacks of flour, cases of whiskey, television sets, airplane engines, crates of chinaware, and a variety of other items. Loading and unloading such a mixture of items of varying shapes and sizes requires much time and labor and is, therefore, expensive. As a result, the number of ships designed to carry only one type of cargo—tankers and dry bulk carriers, for example—has increased. Revolutionary versions of the general cargo freighter have also been developed. They include container ships, roll-on/roll-off ships, and LASH ships.

Container ships eliminate the individual hatches, holds, and derricks of the traditional general cargo vessel. The hull of a container ship is simply an enormous warehouse divided into *cells* by vertical guide rails. The cells are designed to hold cargo in prepackaged units called *containers.* Most containers consist of a standard-

General cargo ships

General cargo ships carry "package" goods—that is, anything that can be put into a package or that forms a package in itself. Loading such cargo onto a ship and fitting the individual pieces into the holds require much time and labor—and are therefore costly.



David R. Frazier

Edward Nyren, Shostal

The colored areas in the diagram, *above left,* indicate the cargo holds of a general cargo ship. The picture, *left,* shows a modern vessel. Most cargo is swung aboard on flat platforms called *pallets, above,* or in nets called *slings.* Derricks on the ship lift the cargo from the dock and lower it into the cargo holds.

sized aluminum box that measures either 20 feet (6 meters) by 8 feet (2.4 meters) by 8 feet or 40 feet (12 meters) by 8 feet by 8 feet. A 40-foot container is about the size of a railroad car.

Manufacturers load their finished goods—anything from perfume to electronic products—into the containers, which are provided by the shipping company. They then have the containers delivered to the dock for loading onto the container ship. The ship does not need a large gang of workers spending hours to fit various items into different holds. Giant cranes pick up the containers, swing them over the ship, and lower them one upon the other into the cells. After the hold has been loaded, additional containers are stacked on the deck.

Containerization saves shippers much money. A container ship can be loaded and unloaded in a small fraction of the time it takes for a conventional cargo vessel. Thus, labor costs are cut sharply. There is also less breakage and less danger of cargo shifting during a voyage. In addition, there is far less theft of valuable merchandise because the containers are sealed.

The largest container ships measure about 700 feet (210 meters) long. They can carry more than a thousand 20-foot (6-meter) containers that hold a total of about 12,000 short tons (10,900 metric tons) of cargo. These ships can make a round trip between Europe and the United States in 21 days. Because of this fast time, each of these ships equals the cargo-carrying capacity of 17 standard World War II freighters.

Many shipping companies believe that containerization is the greatest advancement in shipping since the invention of the steamship. Containerization of cargo began about the mid-1950's. Today, major shipping companies throughout the world operate or are building fleets of container ships.

Roll-on/roll-off ships, also known as *ro-ro ships,* take containers mounted on a framework of wheels like a truck trailer. These ships have a stern opening and side openings. Dockworkers drive the containers up ramps onto the ships and then, by way of inboard ramps or elevators, take them to their assigned places. Ro-ro ships also haul cars, buses, house trailers, trucks, and any other cargo that can be rolled aboard. An international partnership, the Atlantic Container Line, put the world's largest ro-ro ships into operation in 1987. The five ships are each 958 feet (292 meters) long and can do 18 knots. Each one can carry about 1,100 40-foot (12-meter) containers and about 1,000 cars and trucks.

LASH ships are huge freighters that carry preloaded seagoing *lighters* (barges) stacked one upon the other.

Container ships

Container ships carry goods of all kinds in metal containers, most of which measure 8 feet (2.4 meters) deep, 8 feet wide, and 20 or 40 feet (6 or 12 meters) long. A container ship can be loaded and unloaded in about a fifth of the time it takes for a regular cargo ship.

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The colored areas in the diagram, *above left,* indicate the cargo space on a container ship. The picture above shows a giant crane stacking containers in a ship's cells. After all the cells are filled, additional containers are stacked on the deck. The fully loaded ship, *left,* then leaves the port facility.

Bertrand Duruel, Explorer

Roll-on/roll-off ships carry automobiles, trucks, and any other cargo that can be rolled aboard through stern or side openings. Some of these ships are also equipped to handle containers.

Grant Heilman

LASH ships carry *lighters* (barges) preloaded with any kind of cargo. *LASH* means *L*ighter *A*board *SH*ip. Cranes on the carrier ship lift the lighters aboard and unload them.

The term *LASH* stands for *L*ighter *A*board *SH*ip. The lighters are loaded at upriver ports with any kind of cargo and then towed by tugs to the seaport. There, cranes on the carrier ship lift the barges on board. The freighter then carries the barges to a seaport across the ocean. There, the barges are lowered into the harbor and then towed upstream to their final ports.

LASH ships measure up to 875 feet (267 meters) long and 107 feet (33 meters) wide and can travel at 20 knots. They can hold from 70 to 90 barges, each of which can carry 370 short tons (336 metric tons) of cargo. The first LASH ship, the *Acadia Forest,* began operation in 1969 between New Orleans, Louisiana, and Rotterdam, the Netherlands.

Modernization of ports. Container ships need special port facilities. Throughout the world, ports are being built or modernized to handle these vessels. The new facilities have giant cranes and other lifting equipment because container ships have few or no derricks. In port, the ships chiefly need large open areas where their thousands of containers can be left while awaiting loading or pickup. The most advanced ports use computers to assign the loading and pickup areas.

Tankers

Tankers were among the first ships designed to carry only one kind of cargo—petroleum. Earlier ships carried oil in barrels and then in large tanks. In 1878, Ludwig Nobel of Sweden launched a ship that was simply one great tank itself. Nobel was the brother of Alfred Nobel, founder of the famous Nobel Prizes. His tanker hauled oil from the Baku fields in southeastern Russia (now part of Azerbaijan) across the Caspian Sea.

In 1885, the first oceangoing tanker, the *Glückauf,* was launched. This ship, built in the United Kingdom for a German oil company, carried petroleum from the United States to Europe. It became the model for all later tankers. Its hold space had eight big tanks, and its engine room was set in the stern to reduce the danger of fire. The vessel was 300 feet (90 meters) long and 37 feet (11 meters) wide. It carried 2,300 short tons (2,090 metric tons) of oil and could travel 9 knots.

Today, large tankers, often called *supertankers,* can measure more than 1,500 feet (460 meters) long and 200 feet (60 meters) wide. They carry about 1.1 billion pounds (505 million kilograms) of oil and can do about 15 knots. Even larger supertankers are being planned and built. Most supertankers are used to transport oil from the Middle East to Europe and Japan.

Supertankers have various economic advantages over smaller tankers. For example, it costs much less to ship a large amount of oil in one supertanker than in many small tankers. But supertankers also have major disadvantages. Their huge size makes them difficult to navigate and increases the risk of accidents. Because of their size, supertankers require ports as deep as 100 feet (30 meters) in order to unload. If a supertanker suffers an oil spill, the pollution that results could be disastrous because of the ship's huge capacity.

Most tankers carry petroleum. But some tankers are designed to haul other kinds of liquid cargo, such as liquid natural gas (see **Tanker** [Liquefied natural gas carriers]). Ships called *ore/bulk/oil carriers* (OBO's) can serve as either tankers or dry bulk carriers. These ships are discussed in the following section of this article.

Dry bulk carriers

Dry bulk carriers transport fertilizer, grain, ore, powdered detergents, salt, sugar, wood chips, or any other cargo that can be piled loose into a hold. The first modern bulk carriers included the specially designed boats that began hauling iron ore on the Great Lakes during the late 1800's. Like tankers, these vessels were designed to carry only one kind of cargo. But unlike tankers, the ore carriers hauled solid cargo. As a result, they required more complicated loading and unloading

arrangements than tankers, which needed little more than hose connections and pumps.

The Great Lakes ore carrier resembled a long steel box. It had a forecastle to accommodate the crew and bridge at the bow, and a poop to house the engines at the stern. Between the forecastle and the poop, there was a long bin to hold iron ore. Modern Great Lakes freighters have the same basic design, but they are larger than the earlier carriers. The largest vessels today are more than 700 feet (210 meters) long and carry up to 25,000 short tons (22,700 metric tons).

In addition, oceangoing bulk carriers have grown larger and larger. The biggest ones can carry more than 100,000 short tons (91,000 metric tons) of cargo. A modern seagoing bulk carrier has the bridge and engine room near the stern. The rest of the ship is a level area of deck with a line of hatches. Motor-driven equipment on board is used to quickly remove the enormous hatch covers.

During the late 1950's, shipbuilders began to design vessels that could haul either ore or oil. These ships are called *ore/oil* carriers. During the 1960's, OBO carriers appeared. An OBO ship can haul ore; bulk cargo, such as grain or fertilizer; or oil. Some OBO's do not carry ore. The largest ore/oil ship can haul about 250,000 short tons (225,000 metric tons) of cargo. The largest OBO vessels can carry about 150,000 short tons (135,000 metric tons).

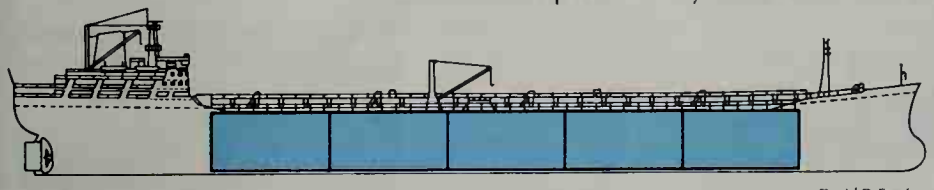
Barges are somewhat like small bulk carriers. These boxlike vessels haul such cargoes as cement, coal, grain, gravel, and sand across harbors, on canals and rivers, and along coasts. Before the invention of power-driven machinery, sails propelled most canal and river barges. In areas where the wind was unreliable, people or animals trudged along the bank of a canal or river and pulled the barges. In Egypt, India, and some other countries, barges are still towed in this way. Modern barges have diesel motors or are pushed or towed by tugs. The size of a canal or river barge is limited by the waterway on which it operates. The barge must be short enough to make the curves in the waterway and narrow enough to pass through canals. Barges that operate in coastal waters can be practically any size.

Multipurpose ships

Multipurpose ships are designed to haul several kinds of cargo at the same time. An example is the British ship *Strathardle,* launched in 1967. It has refrigerated space for foods that spoil easily, tank space for liquid cargo, and a deck for automobiles. The vessel is 563 feet

Tankers

Most tankers transport petroleum, but some are specially designed to haul other kinds of liquid cargo, such as liquid natural gas. The interior of an oil tanker resembles a huge ice cube tray. It is divided into separate tanks by bulkheads that run across the width and length of the ship.



David R. Frazier

© Bruce Brander, Photo Researchers

The colored areas in the diagram, *above left,* indicate the separate tanks that make up an oil tanker's cargo space. Petroleum is pumped into a tanker at oil terminals through large hoses. The picture, *left,* shows an oceangoing modern tanker after loading. The ship's own pumps unload the oil, *above.*

(172 meters) long and 80 feet (24 meters) wide. Another multipurpose ship is the *Bore VI,* a small Finnish freighter also built in 1967. It hauls roll-on/roll-off vehicles, large rolls of paper, packaged lumber, and general cargo. This ship is 290 feet (88 meters) long and 49 feet (15 meters) wide. In 1968, the *Mormacsea,* the first American-built multipurpose vessel, was launched. This vessel can carry containers, roll-on/roll-off cargo, and general cargo. It also has refrigerated space. The *Mormacsea* measures 602 feet (183 meters) long and 90 feet (27 meters) wide.

Specialized types of vessels

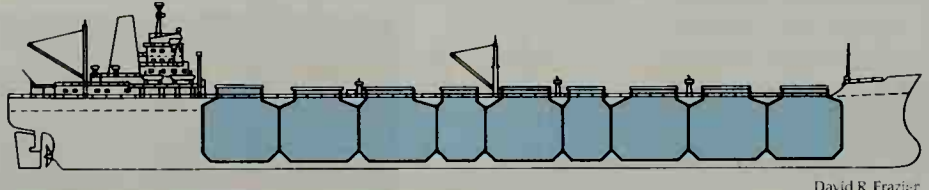
Many ships and boats have been designed to do particular jobs. Refrigerator ships, traveling 22 knots or faster, speed fresh fruits, meats, and vegetables across the ocean. Tugboats tow barges along canals and rivers and guide huge passenger liners and freighters in and out of harbors. Oceangoing tugs take part in rescue and salvage work. Besides ferries that transport automobiles and passengers, there are train ferries that carry railroad cars across small bodies of water. Powerful icebreakers use their sturdy bows to ram through frozen waters and open a path for other ships and boats. Oceanographic ships carry instruments to study currents, tides, waves, and the animals and plants of the sea. Some modern fishing vessels are used not only to catch fish, but also to process them. These ships have equipment to behead, clean, and refrigerate the fish.

Ships of the future

Future ships will be even more efficient than those of today and so will cost less to operate. More and more ships will carry containerized cargo, and all ships will be larger. Ships will become increasingly automated. A staff of engineers will no longer need to stand watch in the engine room. Instead, ship engines will be operated from the bridge, just as plane engines are run from the pilot's cabin. Electronic equipment will navigate tomorrow's ships automatically. A computer will determine a ship's course and, by sending the information to machinery that regulates the rudder, steer the vessel. As a result of these developments, ship officers will receive increased technical training. Crews will become smaller. Ship maintenance will no longer be done at sea by the crew, but in port by specialized workers. To avoid such maintenance work as painting, the bridge, cabins, and other structures on the main deck will be built of aluminum and other materials that do not rust and that resist wear from the chemicals in seawater.

Bulk carriers

Dry bulk carriers haul grain, ore, and other cargo that can be loaded *in bulk* (loose). Bulk carriers called *ore/oil* ships carry ore or oil. *OBO* ships carry oil or ore or other dry bulk cargo. These *combination* ships do not haul oil and dry cargo at the same time.



David R. Frazier

© Martin Rogers, FPG

The colored areas in the diagram, *above left,* indicate the holds of an OBO ship. The picture, *left,* shows a bulk carrier that hauls grain. Most dry cargo is loaded and unloaded by power scoops or by such shore-based suction devices as this one, *above,* shown loading grain. Some bulk carriers have built-in conveyors.

The officers and crew of a ship work as a team to see that the passengers, the cargo, and the ship itself arrive at their destination safely and on time. To sail a ship long distances across open water requires great skill and experience. A change in the wind's strength or direction, or the force of the waves and currents, can put a ship off course. A ship's officers use equipment and methods developed hundreds of years ago—as well as modern devices—to tell where their ship is at all times.

Officers and crew. A highly organized team of officers commands a ship. The top officer, called the *captain* or *master,* has final authority over and final responsibility for the passengers, crew, cargo, and ship. The captain has a number of deck officers, called *mates,* as assistants. The captain has at least a chief, or first, mate; a second mate; and a third mate. On large passenger ships, the captain may have one or two additional mates. All these officers must have a license, which they receive after passing a test given by a nation's government or some other authority. The U.S. Coast Guard issues licenses to officers on American merchant ships. The officers navigate the ship and command the deck crew.

The deck crew consists of *able-bodied seamen* (A.B.'s) and *ordinary seamen.* On American ships, both groups of seamen must hold certificates issued by the Coast Guard. Able-bodied seamen have more experience than ordinary seamen and have the more responsible tasks, such as standing lookout, helping steer, and making difficult repairs. Ordinary seamen do maintenance work.

The engine room has a separate organization. It is headed by a *chief engineer,* who is aided by first, second, and third *assistant engineers.* Like the captain and deck officers, all the engineers must have a license. The crew members in the engine room of a ship driven by steam turbines include oilers, who help tend the engines, and firemen, who fire the boilers.

A ship also has a number of other crew members. They include a chief radio operator; a chief steward, who is in charge of obtaining, preparing, and serving food; one or two cooks; and a mess staff, who serve the meals and assist the cooks.

Cargo and passenger ships carry the same basic groups of crew members. But large passenger liners and cruise ships have much larger crews to make a voyage as pleasant as possible for the passengers. The extra crew members include bakers, barbers and beauticians, bartenders, butchers, doctors and nurses, entertainers, launderers, printers, *pursers* (accountants), recreation directors, and a large staff of stewards and stewardesses. A big passenger or cruise ship may carry as many as one crew member for every two passengers.

Navigating a ship. When a large ship leaves port, three or four small tugboats pull it from the pier into the harbor. A *docking pilot* directs the tugs and the ship until the vessel clears the pier and is underway in the harbor. The tugs then leave the ship and the docking pilot turns the vessel over to a *harbor pilot.* Every merchant ship enters and leaves port with a local harbor pilot aboard.

The harbor pilot guides the ship into the harbor or out into open water. The harbor pilot must know every channel, turn, sand bar, or other obstacle that could endanger the vessel. After a ship reaches open sea, a small boat comes out and carries the pilot back to port. The ship officers then navigate the vessel to its destination.

F. Gordon & Sons from FPG

The bridge of a modern ship has highly accurate navigation equipment for steering the vessel and keeping it safely on course under all conditions. Such equipment includes radar, an automatic pilot, and an electronic navigation system.

On the bridge, the navigator, usually the second mate, uses various equipment to locate the ship's position. As sailors have done for thousands of years, the navigator checks the position by observing the sun, moon, planets, and stars. For hundreds of years, the most important navigation devices have included a *compass* to tell direction, a *chronometer* to tell the exact time and help determine a ship's longitude, and a *sextant* to calculate a ship's latitude by measuring the angle of the sun or of a star above the horizon. See **Compass; Chronometer; Sextant.**

Modern ships also have highly accurate electronic navigation equipment. Many ships have devices for determining their position through radio signals. These signals are sent out continuously by special transmitting stations along the coasts of busy trade routes. One such system is called *loran,* for *lo*ng *r*ange *n*avigation. With loran, an accurate position can be obtained in bad weather and poor visibility without a compass, chronometer, or sextant (see **Loran**). Many ships also can determine their position by signals that are transmitted from orbiting satellites.

Modern ships also carry radar. At night and in bad weather, a ship's radar can spot icebergs, rocks, and other vessels in time to prevent a collision (see **Radar**). Some modern ships also have an automatic pilot, which, after a ship has been set on course, holds it there. This device is linked to a *gyrocompass,* which determines direction, and it operates the rudder automatically (see **Gyrocompass**). In spite of all these remarkable devices,

navigators still also use the tried-and-true compass, chronometer, and sextant. For more information on how ships are navigated, see **Navigation.**

Automation aboard ships is increasing, but no ship is as yet completely automated. Most automation has been in the engine room. When the officer on the bridge signals the engines to go ahead or backward or to change speed, the engineer no longer has to make adjustments by hand. Instead, the engines respond immediately. The operation of the valves and the necessary change in temperature or pressure are taken care of automatically. Many ships have automatic navigation aids and automatic devices to speed up the loading and unloading of cargo. Automation may one day make it possible for cargo ships to have only 9 or 10 crew members.

Safety at sea. Safety standards for ships have been set up by International Safety of Life at Sea conventions, which were held in 1914, 1929, 1948, 1960, and 1972. All the major maritime nations have agreed to these standards. The standards require that ships have watertight *bulkheads* (compartment walls); fire-fighting equipment; and enough lifeboats, life jackets, and other lifesaving equipment. Other rules provide that lifesaving and fire drills be carried out at regular intervals. In addition, ships must follow the International Rules of the Road. These rules deal with such points as the rights of way of ships on the high seas, the lights ships must show, and the signals that ships must give in fog and during times of distress.

In 1930, all the leading seafaring countries accepted rules set up by the International Load Convention to keep ships from being overloaded. These rules require that cargo ships have a series of short lines painted on their side to show the depth to which the vessels may be safely loaded at various times of the year and in various waters. When a ship, being loaded with cargo, sinks in the water to a certain line, it has reached the maximum load. The lines are called *Plimsoll marks.* They are named after Samuel Plimsoll, a member of the British Parliament who brought about their adoption in Great Britain's Merchant Shipping Act of 1876. In 1966, the world's maritime nations agreed to new rules that raised the limits to which ships may be safely loaded. The new rules reflected improvements in ship design and construction since 1930. See **Plimsoll mark.**

In addition to international maritime laws, individual countries have regulations governing the construction and operation of their own ships. The United States has especially high safety requirements. In many cases, its standards are far higher than international rules require. These strict standards have made American ships exceptionally safe. They have also made U.S. ships much more costly to build and operate than foreign ships.

The U.S. Coast Guard sees that American vessels meet the standards set up by the federal government. The Coast Guard must approve the construction plans for each new ship. It inspects the ships during their construction to make sure that they are being built according to the plans. At regular periods, the Coast Guard also checks all merchant ships in active service to make sure that they meet all safety regulations.

The art of shipbuilding

A ship is one of the most complicated objects ever made. It is actually a floating city that generates its own power, heat, and electricity. A ship carries its own fuel and provisions. It can make its own fresh water from the sea, and it disposes of its own garbage.

All ships have four main parts. In designing a ship, naval architects plan these and other parts of the vessel so that it meets a shipping company's special needs as well as government safety regulations. A shipyard then builds the ship according to the architect's plans.

The chief parts of a ship are (1) the hull, (2) the engines, (3) the propellers, and (4) the rudder.

The hull is the watertight shell of a ship. It is divided into a number of horizontal surfaces called *decks. Bulkheads* are walls built between the decks, forming compartments. Each compartment has special doors that, when closed, make it watertight. If water floods one compartment because of an accident, closing the doors will trap the water there and prevent it from flooding other compartments. Watertight compartments enable a ship to float even with a hole in its hull.

The deck at the top of the hull is called the *main deck.* Several more decks may be above it. All the structures above the main deck make up the *superstructure.*

Hulls have a pointed bow so they can knife swiftly through the water. Most hulls also have a rounded stern, which helps the water close smoothly behind as the ship cuts through the water. The overall shape of a hull is designed to make the ship as *stable* (steady) as possible. A ship must not *roll* (rock from side to side) or *pitch* (rock from front to back) too much. Most modern ships also use stabilizing systems to reduce rolling. One such system has a horizontal underwater fin on each side of the hull. The fin moves upward on the descending side of the ship and downward on the ascending side and so reduces the roll.

To increase stability further, ships carry extra weight called *ballast.* Without ballast, an empty cargo ship would bobble about in the ocean like a cork. Most ships use seawater as ballast. As a ship takes on cargo, the ballast water is pumped out.

The engines of most ships are steam turbines, gas turbines, or diesel engines. The largest and fastest ships have steam turbines. Steam produced in the boilers spins the bladed wheels of the turbine. The turbine, through a series of *gears* (toothed wheels), drives the propeller shaft and makes the propeller revolve. On turboelectric ships, the turbine turns a generator that produces electricity for a motor. The motor, in turn, drives the propeller. Almost all merchant ships use oil as the fuel to heat the boilers that create the steam. On nuclear-powered ships, a nuclear reactor creates the steam. Many of the most advanced ships have gas turbines. Gas turbines work much like steam turbines but use hot gases instead of steam. See **Turbine.**

Vessels propelled by diesel engines are called *motorships.* They have either *geared-drive* or *diesel-electric* machinery. On a geared-drive ship, the engine works through gears to turn the propeller. On a diesel-electric ship, the engine turns a generator that supplies current to an electric motor connected to the propeller shaft. See **Diesel engine.**

The propellers, also called *screws,* move a ship through the water. The engine turns a shaft that juts out underwater from the stern. The propeller is bolted to the end of the shaft. Most propellers have four blades. As a propeller turns, it screws itself through the water and so pushes the ship forward. Most small ships have one propeller. Many larger vessels have two propellers, and very big ships have four. Additional screws increase a ship's power and make the vessel easier to maneuver. For example, a twin-screw ship can be swung around quickly by going forward on one propeller and backward on the other. Some ships have an extra propeller called a *bow thruster.* This propeller, which is located in the bow, turns the ship more rapidly than stern propellers alone. See Propeller (Marine propellers).

The rudder is a large flat piece of metal that steers a ship. It is hinged to the stern and so can be swung like a door. The rudder is connected to the *helm* (steering wheel) on the ship's bridge. When the sailor at the helm turns the wheel to the right, the rudder moves to the right, causing the stern to swing left and the bow to swing right. When the helm is turned to the left, the rudder and bow swing to the left.

Other parts and equipment of a ship include *funnels* (smokestacks) to discharge smoke and exhaust fumes, an anchor on the left and right sides of the bow, and enough lifeboats to hold all persons on board. Modern ships have power-driven *winches* to raise or lower the anchors and to bring in or let out the *mooring lines* used to tie vessels at a pier. Power-driven winches also operate the cranes for loading and unloading cargo. Modern ships also have high-speed pumps to pump out ballast water or to pump up seawater in case of fire. Radio-telegraph equipment keeps ships in constant touch with the rest of the world.

Designing and constructing a ship. Before naval architects begin to design a ship for a shipping company, they must know how the firm plans to use the vessel. They must know where the ship will sail, what kind of cargo it will carry, and how fast it will have to travel. Architects also must be aware of government safety regulations. In addition, they must adjust their designs to allow for the ever-increasing use of automation on ships.

The shipyard carefully follows the architect's designs in building a ship. Traditionally, construction begins with the laying of the keel. Workers then build the ribs that support the hull and give it shape. Next, they weld the metal plates that form the middle section of the hull. As the middle section is built, the various compartments, the boilers, and the machinery are added. Finally, the bow and stern are built, completing the hull.

Modern shipyards no longer construct ships in this piece-by-piece manner. Instead, they first build enormous prefabricated sections of the ship in subassembly shops. Many of these sections have some wiring and piping built into them. Giant cranes then carry these huge sections to a framework called a *shipway,* where they are welded together. There is no laying of the keel. As the double-bottom sections of the hull are welded together, the keel is laid automatically. The entire hull may consist of as few as 20 prefabricated units. After the hull is completed, parts of the superstructure are added. The ship is then ready to be launched.

Launching and outfitting a ship. Shipbuilders launch a ship after it is about 70 to 90 percent completed. The ship is slid down a runway of heavily greased timbers into the water. Most ships are launched stern first. A ship launched bow first would plow down into the mud. Ships built along rivers too narrow for stern launching are launched sideways. Some yards build their ships in dry docks below the water level. After the hull and superstructure have been completed, workers open the valves and flood the dock. The ship then gently floats off the blocks that supported it. After the water inside the dock reaches the level of the water outside it, the dock gate is opened and the ship is launched.

Just before a ship is launched, it is christened. The shipping company selects a person, usually a woman, as the ship's sponsor. This person names the vessel and breaks a bottle of champagne across its bow. At that instant, the ship begins to slide into the water.

After a ship has been launched, a tug pulls it to an *outfitting pier.* There, workers complete the superstructure and add the interior furnishings. The ship then makes its *builder's trials* with observers aboard from the company that ordered the ship. They make sure that all the equipment is in good working order and that the ship performs maneuvering, speed, and other tests according to the specifications. If the ship returns from the trials with a broom tied to the mainmast, it has made a "clean sweep" of its tests and the shipping company has accepted delivery of the vessel.

Merchant fleets of the world

Altogether, the countries of the world have about 80,000 merchant ships. About 25,000 of these ships are of 1,000 gross tons or more. The world's merchant vessels total more than 400 million gross tons. Each year, millions of gross tons of new shipping are built. Japan and South Korea produce most of the total gross tonnage of ships launched annually.

In the United States and a number of other countries, many companies register their ships under the flag of another nation. They do this in order to operate their vessels with lower-paid crews, avoid strict safety regulations, and pay lower taxes than they would by registering in their own countries. A number of nations allow their flag to be used in this way as a flag of convenience for a registration fee. Countries that have a flag of convenience include the Bahamas, Honduras, Liberia, Panama, and the Philippines.

The United States merchant marine consists of about 6,300 vessels, including those that sail the Great Lakes and other inland waterways. All of these vessels are registered in the United States and fly the American flag. The size of the United States merchant fleet and the fleets of other maritime nations varies according to the level of world trade. In addition, many United States

merchant ships are inactive or past the age of active use. The United States has only about 150 American-flag ships engaged in its foreign trade. The United States is the chief trading country in the world. Yet American-flag ships carry only about 4 percent of the country's foreign trade.

The federal government requires that all merchant ships registered under the United States flag must be American-built and operated by American crews. But building and operating ships costs about 50 percent more in the United States than in the lowest-cost shipyards, which are located mainly in Asia. American-flag ships can compete against foreign vessels only with the help of *subsidies* (grants of money) from the government. The government grants subsidies because it believes that a merchant fleet is vital to the country's foreign trade and national defense. For example, without a merchant marine, the nation would be completely dependent on foreign shipping lines—which owe no allegiance to the United States—to carry American trade. During wartime, U.S. cargo ships are needed to carry supplies, and shipyards in the United States must be in operation to build warships.

Under the Merchant Marine Act of 1936, the Maritime Administration has control over subsidized shipping lines. The act requires that such lines provide regular service on trade routes that the administration selects as essential to United States foreign trade and defense. Subsidized operators must also replace ships that the administration considers too old and inefficient for service.

Many American ship operators prefer not to accept government subsidies. Instead, they buy their ships from foreign shipyards at about 50 percent less than American-built vessels and register them in a country that has a flag of convenience.

Merchant fleets of other countries. Many countries have a long tradition as seafaring nations. They include Denmark, France, Italy, the Netherlands, Norway, Sweden, and the United Kingdom. In addition, Japan and a number of other nations have developed large fleets of ships.

Panama and Liberia have the largest merchant fleets in the world. Each country allows its flag to be used as a flag of convenience. Companies of other countries own almost all the ships of the Panamanian and Liberian fleets.

Philip Chadwick Foster Smith

Leading merchant fleets of the world

Gross tons of ships registered in each country*

Panama	98,499,972 gross tons 4,632 ships
Liberia	59,804,012 gross tons 1,651 ships
Bahamas	26,631,924 gross tons 1,079 ships
Greece	24,798,431 gross tons 810 ships
Malta	24,436,956 gross tons 1,361 ships
Cyprus	23,362,067 gross tons 1,469 ships
Norway	21,200,416 gross tons 788 ships
Singapore	19,734,146 gross tons 875 ships
China	16,828,349 gross tons 1,759 ships
Japan	13,753,027 gross tons 713 ships
United States	11,123,848 gross tons 385 ships
St. Vincent and the Grenadines	7,726,930 gross tons 814 ships
Germany	7,699,596 gross tons 594 ships
India	6,627,497 gross tons 311 ships

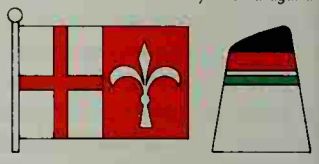
*Includes ships of 1,000 gross tons or more.
Figures are for Jan. 1, 1999.
Source: United States Central Intelligence Agency.

Flags and funnels of shipping companies

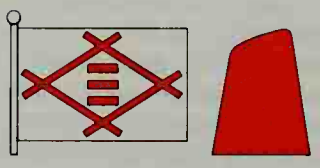
Shipping companies fly a private flag, called a *house flag*, to identify the ships they own or operate. On many merchant ships, the colors and emblem of the flag also appear on the funnel.

WORLD BOOK illustration by Mas Nakagawa

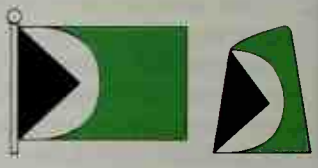
American President Lines
(United States)



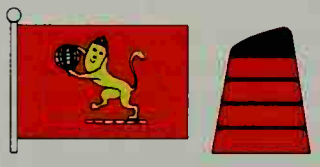
Italian Line
(Italy)



Mitsui O.S.K. Lines, Ltd.
(Japan)



Canadian Pacific (CP Ships)
(Canada)



Cunard Line Ltd.
(United Kingdom)

French Line (Compagnie Générale Transatlantique)
(France)

Related articles in *World Book* include:

Biographies

Cunard, Sir Samuel
Ericsson, John
Fitch, John
Fulton, Robert
Kaiser, Henry J.
Maury, Matthew F.
McKay, Donald
Sperry, Elmer A.
Stevens, John
Stevens, Robert L.

Famous merchant ships

Clermont
Lusitania
Mayflower
Savannah
Titanic

Kinds of ships

Air cushion vehicle
Barge
Brig
Caravel
Clipper ship
Cruise ship
Ferry
Flatboat
Frigate
Galleon
Galley
Hydrofoil
Icebreaker
Junk
Steamboat
Tanker
Tugboat

Parts of a ship

Anchor
Gyrocompass
Propeller

Other related articles

Barnacle
Boating
Coast Guard, United States
Customs Service, United States
Dry dock
Federal Maritime Commission
Flag (Kinds of flags)
Freight
Harbor
Inland waterway
Insurance (Marine insurance)
International Maritime Organization
Knot
Log
Maritime Administration
Maritime law
Merchant marine
Navigation
Navy
Port
Radar (In ship navigation)
Sailing
Salvage
Ship, Model
Shipwreck
Transportation
Weather (Measuring the weather)

Outline

I. History
II. Ships of today
A. Passenger vessels
B. Classification of cargo ships
C. General cargo ships
D. Tankers
E. Dry bulk carriers
F. Multipurpose ships
G. Specialized types of vessels
H. Ships of the future
III. A ship at sea
A. Officers and crew
B. Navigating a ship
C. Automation aboard ships
D. Safety at sea
IV. The art of shipbuilding
A. The chief parts of a ship
B. Designing and constructing a ship
C. Launching and outfitting a ship
V. Merchant fleets of the world
A. The United States merchant marine
B. Merchant fleets of other countries

Questions

What is a *flag of convenience*? Why do many American shipbuilders register their ships under these flags?
What was the first commercially successful steamboat? Who built it?
Why has the transatlantic passenger liner service declined sharply since the late 1940's?
What does it mean if a new ship comes back from its builder's trials with a broom tied to the mainmast?
Who was Donald McKay? Isambard Kingdom Brunel? John Fitch?
What is the difference between a tramp ship and a cargo liner?
Why did the invention and development of the steam engine revolutionize water transportation?
What are some of the standards of safety that ships are required to follow?
How does a container ship differ from a traditional general cargo ship?
What does a docking pilot do? A harbor pilot?

Additional resources

Level I

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Humble, Richard. *Submarines and Ships.* Viking, 1997.
The Visual Dictionary of Ships and Sailing. Dorling Kindersley, 1991.
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Level II

Aak to Zumbra: A Dictionary of the World's Watercraft. Mariners' Museum, 2001.
Delgado, James, and Clifford, J. C. *Great American Ships.* 1991. Reprint. Wiley, 1995.
Hoehling, A. A. *Ships That Changed History.* 1992. Reprint. Madison Bks., 1994.
Paine, Lincoln P. *Ships of the World: An Historical Encyclopedia.* Houghton, 1997.
Woodman, Richard. *The History of the Ship.* Lyons Pr., 1997.

Ship, Model, is a small copy of a full-sized ship or boat. Making model ships can be a fascinating hobby. Some hobbyists carve models by hand. Others make boats and ships from accurate kits sold by hobby shops. These models are made of plastic or wood. Model sailboats are popular, and some sailboat modelmakers belong to clubs that sponsor races.

Sailors on long voyages often made model ships in narrow-necked bottles. These make interesting collectors' items. The spars and rigging were made in fine detail. When the model was finished, the sailor inserted it in the bottle with the spars and rigging lying down. A pull of one thread drew the rigging upright.

Model ships also play an important part in the shipbuilding industry. Old-time shipbuilders carved models to guide the workers. They used no blueprints or plans. Today, preliminary models help designers select the final form of a ship's hull before they draw the design. These models are tested in a towing tank to provide information on how the hull of a full-sized ship will act at sea and at various speeds. All important commercial and naval ship designers tank-test preliminary models.

T. Nebbia, DPI

Model ships provide accurate re-creations of vessels of the past. This craftworker in Greenland is producing carefully researched models of Viking long ships to sell as souvenirs.

Beginning in the 1960's, there was a growing interest in operating models due to the availability of radio control equipment. Most operating models are intended for racing, sport operation, or as scale replicas. They are built from kits, magazine plans, or original designs. Power boats are propelled by internal combustion engines, steam engines, or electric motors. Ralph P. Warner

See also Maine (Places to visit [Penobscot Marine Museum]).

Shipley, Jenny (1952-), was prime minister of New Zealand from 1997 to 1999. She was the first woman to hold that office. Shipley, a National Party politician, was known for her conservative views. For example, she supported reducing government programs, selling government-owned businesses to private owners, and cutting taxes.

Shipley joined the National Party in 1975 and was first elected to the New Zealand House of Representatives in 1987. She held a number of Cabinet positions from 1990 to 1996. They included minister of social welfare, minister of women's affairs, and minister of health. As minister of health, she received widespread criticism for making a series of cuts in health care services. In late 1997, she replaced Jim Bolger as National Party head and as prime minister. In 1999 elections, the Labour Party won the most seats in Parliament. Helen Clark, the Labour leader, succeeded Shipley as prime minister.

Jenny Shipley was born Jennifer Mary Robson in Gore, on the South Island. She attended Marlborough Girls' College and Christchurch Teachers College. After receiving a teaching diploma in 1971, she taught school. She also worked as a farmer in partnership with Burton R. Shipley, whom she married in 1973. Fiona Barker

Shipping. See Ship.

Shipworm is a wormlike marine animal that bores into wood. A shipworm lives in the tunnel it makes. It bores using a small two-pieced shell at the front end of its body. It then lines the tunnel with a white shell-like material. Shipworms draw in food and water with tubelike organs called *siphons*. Young shipworms look like tiny clams and can move about freely. But they soon attach themselves to wood and begin to bore a tunnel. As the shipworm grows, it bores deeper into the wood. Some shipworms make tunnels more than 3 feet (90 centimeters) long. Shipworms can severely weaken wooden piers and other structures. Robert S. Prezant

Scientific classification. Shipworms are in the family Teredinidae. The scientific name of the common shipworm is *Teredo navalis*.

Shipwreck is the accidental destruction or loss of a ship. A ship may be lost by striking land, another ship,

Major shipwrecks

Year	Ship	Dead	Disaster
1852	*Birkenhead*	420	Wrecked off South Africa
1854	*City of Glasgow*	399	Vanished out of Liverpool
1857	*Central America*	422	Sank on Cuba-New York run
1858	*Austria*	509	Burned in North Atlantic
1859	*Pomona*	388	Wrecked off Ireland
1865	*Sultana*	1,653	Exploded on Mississippi R.
1867	58 vessels	1,000	Hurricane in West Indies
1873	*Atlantic*	500	Wrecked off Nova Scotia
1878	*Princess Alice*	640	Collided in River Thames
1891	*Utopia*	533	Collided off Gibraltar
1895	*Reina Regenta*	402	Foundered near Gibraltar
1898	*La Bourgogne* and *Cromartyshire*	561	Collided off Nova Scotia
1904	*General Slocum*	1,030	Burned in East River, N.Y.
1904	*Norge*	651	Wrecked off Scotland
1912	*Titanic*	1,500	Struck iceberg in N. Atlantic
1914	*Empress of Ireland*	1,029	Collided in St. Lawrence R.
1915	*Eastland*	812	Overturned in Chicago R.
1917	*Mont Blanc*	1,635	Exploded in Halifax Harbour
1931	*St. Philibert*	368	Overturned off France
1942	*Curaçao*	335	Collided off England
1948	*Kiangya*	1,100	Exploded in China Sea
1954	*Toya Maru*	1,172	Sank in Tsugaru St., Japan
1956	*Andrea Doria*	46	Collided off Massachusetts coast; 1,660 rescued
1963	*Thresher*	129	Nuclear submarine sank in North Atlantic
1970	*Namyong-Ho*	308	Sank off South Korea
1981	*Tampomas II*	580	Burned and sank in Java Sea
1986	*Admiral Nakhimov*	398	Collided in Black Sea
1986	*Samia*	600	Sank in cyclone in Meghna R., Bangladesh
1987	*Doña Paz*	1,840	Collided near Philippines
1991	*Salem Express*	475	Struck coral reef near Egypt
1993	*Neptune*	800	Capsized off Haiti
1994	*Estonia*	850	Sank off southwest Finland
1996	*Bukoba*	869	Foundered in Lake Victoria
2000	*Cahaya Bahari*	482	Sank off Sulawesi I., Indonesia
2000	*Kursk*	118	Nuclear submarine exploded, sank in North Sea.

Sources: Lloyd's Register of Shipping; official government sources.

or another floating object, such as an iceberg. Fire also causes shipwrecks.

Radios and other electronic aids to navigation installed on ships make ships safer. The *fathometer* uses sound waves to measure the depth of the water (see Fathometer). *Radar, loran,* and *omega* use radio waves to monitor the location of ships (see Radar; Loran; Navigation [Electronic navigation]).

Although ships are now safer, the impact of shipwrecks that do occur is much more severe. This is because present-day ships can carry more cargo than ever before, and many cargoes are hazardous.

Robert L. Scheina

See also Salvage; Ship (Safety at sea); Titanic.

Shire, *shyr,* was an early geographical division of England. They were first formed in the Anglo-Saxon states during the A.D. 800's. Shires were made up of smaller districts called *hundreds.* About 1400, the English began to call the shires *counties.*

See also England (The Anglo-Saxon period).

Shirley, William (1694-1771), served as colonial governor of Massachusetts from 1741 to 1756. For a short time, he commanded all British forces in North America. He was responsible for the important capture of the French stronghold of Louisbourg in 1745, during the French and Indian wars. When England paid Massachusetts for its part in the war, Shirley redeemed the colony's paper money and built a sound currency. Shirley was born in Sussex, England. John W. Ifkovic

Shiva, *SHEE vuh,* is one of the two leading gods of Hinduism. Vishnu is the other. Shiva, a god of great power, is beyond distinctions of good and evil. Hindus call him *the Destroyer* because he periodically destroys the world in order to re-create it again.

At times, Shiva has a terrifying appearance. Many Hindus believe he haunts graveyards and lives with demons and other supernatural beings. But Shiva's followers consider him a merciful god, despite his fearsome characteristics.

In Hindu philosophy, Shiva avoids taking an active part in human affairs. Hindu works of art show him meditating alone on a mountain. Many Hindus worship Shiva as the physical form of Brahman, the most abstract and absolute form of God. Shiva's wife, who has several names, plays an important part in human affairs.

Charles S. J. White

See also Brahman; Hinduism (Divinities).

Shock is a dangerous condition that can occur if the blood fails to circulate properly in the body. This condition is sometimes called *circulatory shock.* Shock can occur with any serious illness or injury. It can also be caused by emotional stress. Advanced stages of shock affect the vital functions of the body. These stages can be fatal.

A mild form of shock, called *neurogenic shock,* occurs when a person faints (see Fainting). More severe forms of shock progressively worsen if care is not provided. Many cases of the more severe forms of shock result from a sudden drop in the volume of blood circulating through the body, resulting in a drop in blood pressure. This can be caused by internal or external bleeding or by loss of fluid from burns or heat stroke. It can also result from various heart disorders or from blood clots that block circulation. In addition, violent allergic reactions and certain bacterial infections cause blood vessels to expand and so lead to shock.

When a person first goes into shock, he or she perspires heavily and may feel restless, nauseated, or anxious. In most cases, the heart beats faster and breathing becomes rapid and uneven. As shock worsens, the brain does not receive enough blood, causing a change in the level of consciousness. If unaided, a person in this condition loses consciousness and dies.

In most cases, a person in shock should be positioned onto the back with the legs raised slightly. An individual in shock caused by heart trouble or difficult breathing should have the head and shoulders elevated. The person giving aid should maintain the victim's normal body temperature by keeping the victim warm with blankets if it is cool, or by providing shade and cooling the victim if it is hot. Professional medical personnel may provide the victim with fluids and take measures to restore normal blood pressure. A physician may administer drugs that regulate the size of the blood vessels, stimulate the heart, and fight infections or allergic reactions.

Critically reviewed by the American Red Cross

See also Anaphylactic shock; First aid (Treat for shock).

Shock, Electric. See First aid (Restoring breathing); Shock treatment.

Shock absorber is a device that reduces shock or concussion. It is used on automobiles, airplane landing gears, and doors. Automobile shock absorbers also reduce unwanted vehicle motion caused by uneven road surfaces or by turning and braking maneuvers.

Most shock absorbers consist of a piston inside a cylinder containing air or oil. In a car, the force of a bump is transmitted to the shock absorber, pushing the piston upward. But oil in the cylinder resists the piston. This resistance absorbs the shock and offsets the force of the bump. See also Automobile (The support system); Spring (metal); Torsion bar suspension.

William H. Haverdink

Shock treatment is a type of therapy for patients with serious mental illnesses. Shock treatment makes the patient temporarily unconscious. Physicians use it alone or along with psychotherapy (see Psychotherapy).

The first widely used forms of shock treatment were *insulin shock therapy* and *electroconvulsive therapy* (ECT). Both forms were used for treating severe mental illnesses during the 1930's and 1940's. Since 1950, American doctors have used ECT almost exclusively.

When physicians first used insulin to produce unconsciousness, they hoped it would cure schizophrenia. But the treatment helped only in some cases, and it often produced only temporary improvement. For these reasons, and because it is difficult to administer safely, the treatment is no longer used in the United States.

Electroconvulsive therapy was introduced a few years after insulin treatment. ECT produces convulsions, or seizures, in a patient. The simplest and most common method of administering ECT consists of passing an electric current through the patient's brain for a fraction of a second. This form of treatment is also called *electroshock.*

Although ECT is simple to administer, it must be adjusted to each individual case. The number of treatments varies, but most patients receive about three a

week, with a total of 6 to 10 treatments over a two- to three-week period. Physicians determine the amount and the duration of the electric shock by monitoring the patient's brain waves to be sure that a seizure is produced. Pretreatment medications and general anesthesia are usually given so that the patient experiences no discomfort and neither feels the electric current nor consciously experiences the seizure.

The most important use of ECT is to treat hospitalized patients who remain severely depressed and suicidal in spite of drug treatment and psychotherapy. ECT frequently restores these depressed patients to a normal mental state. The reasons it does so are unknown.

ECT is controversial because it has sometimes been used as a punishment to control violent or uncooperative psychiatric patients. In addition, ECT often causes temporary amnesia, and some physicians claim that it also produces long-term memory loss. But there is little evidence to support this claim. Nancy C. Andreasen

See also **Mental illness** (Electroconvulsive therapy [ECT]).

Shock wave is a sharp, intense disturbance or wave in a medium, such as air, water, or even the interior of a star. A weak disturbance generally travels at the speed of sound, a rate that depends on the medium. For example, at sea level and a temperature of 59 °F (15 °C), sound travels through air at 1,116 feet (340 meters) per second. Unlike a weak disturbance, a shock wave has enough energy to travel faster than the speed of sound.

The crack of thunder is a familiar example of a shock wave. Thunder occurs when lightning rapidly heats the surrounding air. As a result, the pressure of the air increases so much that it pushes a shock wave outward. When the rapid pressure increase reaches your ears, you hear a loud "crack."

A sonic boom occurs when an object, such as a jet aircraft, travels through the air faster than the speed of sound. When the pressure of the passing shock wave reaches your ears, you hear a "boom."

A supernova results when the core of a large star cannot produce enough energy to support its outer layers. These layers rapidly collapse onto the core, squeezing it until it stiffens. The infalling layers then rebound, creating a shock wave that travels outward, ripping the star apart. Brian M. Argrow

See also **Aerodynamics** (Supersonic aerodynamics).

Shockley, William (1910-1989), an American physicist, was one of the inventors of the transistor. With John Bardeen and Walter Brattain, he received the 1956 Nobel Prize in physics for discovering the principles that make the transistor possible (see **Transistor**).

Shockley was born in London. At the time the transistor was invented in 1947, he was a physicist at the Bell Telephone Laboratories. He was a professor of engineering at Stanford University from 1963 to 1975.

In the early 1970's, Shockley's views on race and intelligence sparked much controversy. He claimed that heredity, rather than environment, was mainly responsible for whites generally scoring higher than blacks on intelligence tests. Most geneticists and psychologists disagreed with this theory. See **Intelligence** (The roles of heredity and environment). Spencer R. Weart

Shoe is a covering for the foot. Shoes have a sole, and most shoes also have a heel. The upper part of most shoes extends no higher than the ankle. Boots are footwear that reach beyond the ankle. People wear shoes to protect their feet from the environment, sharp objects, and uncomfortable surfaces.

Fashion often determines shoe styles. The desire to be fashionable has led to unusual styles. For example, many European men of the 1300's wore shoes called *crackowes,* which had a very long toe. Some crackowes had a toe so long that it had to be fastened to the knee with a chain to prevent the wearer from tripping. From the 1300's to the 1700's, some European women wore shoes with soles so thick that walking was impossible without support. Shoes once worn in Japan were connected to stilts as high as 6 inches (15 centimeters).

Most shoes are made of leather. Other shoe materials include canvas, velvet, and such synthetic substances as plastics. Materials and styles vary somewhat, depending on climate, custom, and other factors. For example, many farmers in the Netherlands wear heavy wooden shoes to protect their feet from the damp ground. Many Japanese wear shoes outside their home but prefer soft slippers at home.

WORLD BOOK photo

Shoes are manufactured in a variety of styles. This picture shows some of the most popular kinds of footwear. They are, *from left to right,* a dress sandal, a pump, a tennis shoe, a work boot, a moccasin, a loafer, and an oxford.

Kinds of shoes. There are four main kinds of shoes: (1) casual and dress shoes, (2) sport shoes, (3) work shoes, and (4) corrective shoes.

Casual shoes and dress shoes are made for most everyday occasions. Most casual shoes are low-heeled styles, such as the loafer, moccasin, oxford, and pump. Oxfords feature a lacing over a tongue. Loafers, moccasins, and pumps are *slip-on* shoes. Most slip-on shoes have no lace or tongue.

Most dress shoes, or *evening shoes,* for women are based on the pump or sandal style and have high or medium heels. Materials used for these shoes include brocade, satin, silk, tapestry, and velvet. Some men's dress shoes are made of *patent leather* (leather with a glossy finish).

Sport shoes are designed to enhance the performance of athletes and to provide comfort and durability. They have different features for various sports. Basketball shoes and tennis shoes have rubber soles that keep the player from slipping. These soles also prevent the shoes from damaging the playing surface. Baseball shoes have metal or synthetic-rubber spikes that enable the wearer to start and stop quickly. Football shoes have synthetic-rubber cleats for the same purpose.

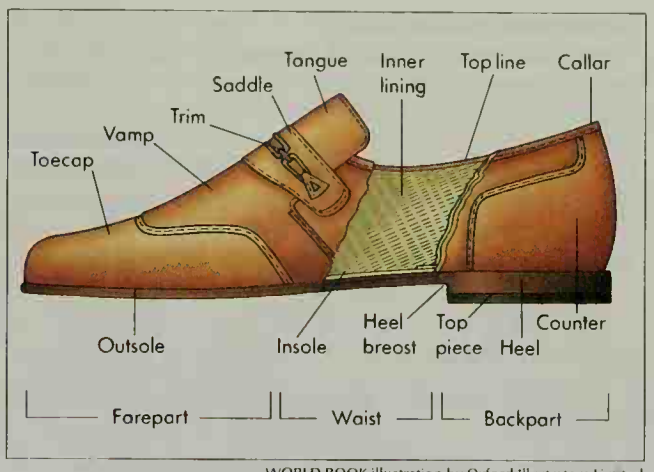
Beginning in the 1960's, more and more people, especially in the United States, became interested in personal fitness. As a result, shoe manufacturers began to produce highly specialized athletic shoes for such activities as running, walking, and aerobic exercise. In addition, cross-training shoes are designed to be appropriate for play of more than one sport. Many people wear athletic shoes for casual dress as well as for sports and other exercise.

Work shoes are worn for safety and comfort in many kinds of jobs. Workers in some industries wear shoes with a steel toecap for protection against injury. Other workers wear footwear designed to prevent burns, to prevent slipping, or to protect the wearer from electrical shock. Most mail carriers, nurses, restaurant workers, and others who must stand or walk for long periods wear shoes that have a cushioned sole.

Corrective shoes are designed to provide relief from such foot conditions as bunions and corns (see **Bunion; Corn**). They also are used for *hammertoes* (toes bent in the form of a claw) and other disorders. Some corrective shoes are ready-made products that have built-in corrections for minor foot problems. For example, one style features a special heel that supports the *arch,* the curved part of the sole of the foot. Other corrective shoes are specially made for one person, some according to a physician's prescription. A person can also have special shoes made to fit the exact shape of the feet—including any corns or other bulges. Such shoes reduce the pressure against these areas.

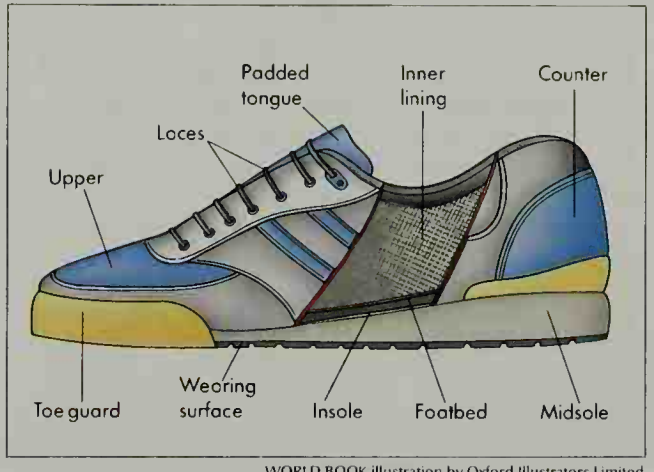
The shoe industry in the United States produces about 250 million pairs of shoes annually. Americans buy more than 850 million pairs of shoes imported from Brazil, China, Indonesia, Taiwan, and other countries yearly.

Shoe manufacturing requires dozens of operations, many of which are highly skilled. First a shoe designer, who generally works for a shoe manufacturer, makes sketches of ideas and decides what colors and materials will be used. The manufacturer produces samples of the shoes, and sales representatives show the samples to buyers from shoe and department stores. The buyers then order shoes from the manufacturer.



WORLD BOOK illustration by Oxford Illustrators Limited

Casual and dress shoes are made for most everyday occasions. The shoes' upper parts are usually soft and flexible for comfort while walking. The hard, stiff soles provide durability.



WORLD BOOK illustration by Oxford Illustrators Limited

Sport shoes are designed to enhance athletic performance. They usually have thick padding to cushion impact and a patterned wearing surface that provides good traction.

At the shoe factory, workers prepare patterns for each component of each size shoe to be manufactured. Using patterns, a worker then cuts sections that will form the *upper* (upper part) of the shoe. The sections of the upper are then joined by stitching or cementing. Next, the upper is pulled over a *last* (a plastic form in the approximate shape of a foot) on a *lasting machine.* A worker then attaches the sole to the upper by stitching, cementing, or molding. Finally, the heel is attached and various finishing operations are carried out.

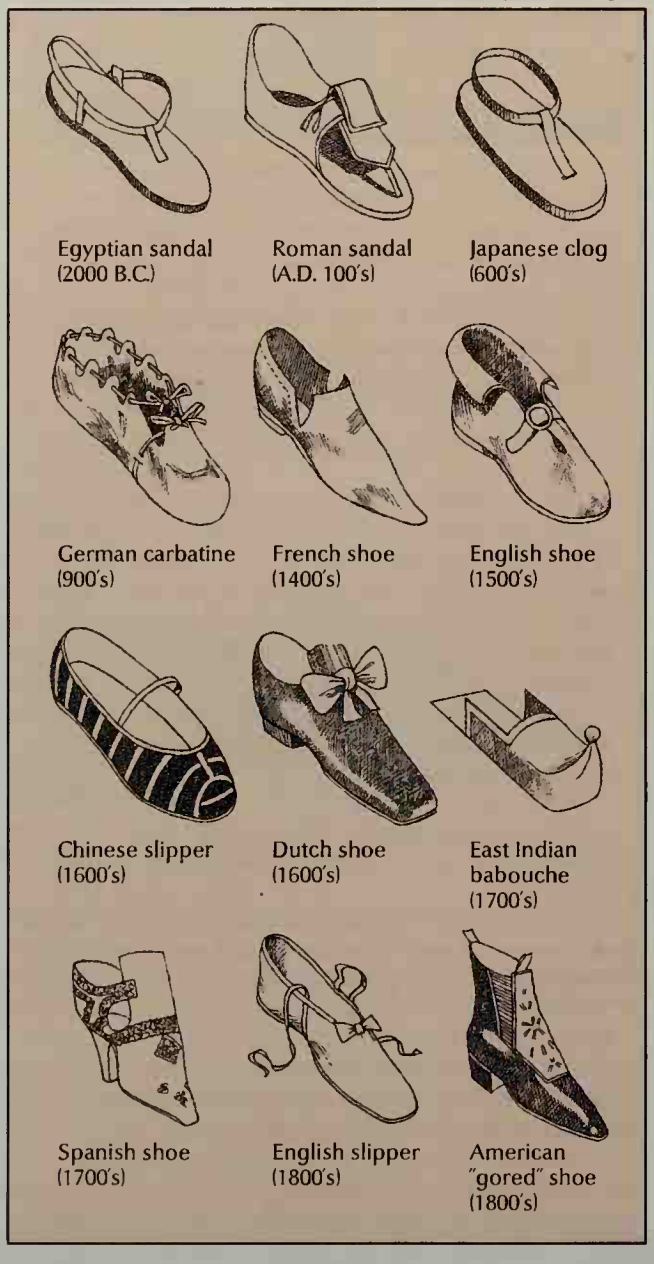
Shoes and health. Shoes that have been poorly fitted can cause such problems as backaches, sore muscles, fatigue, and poor posture. Shoes that are too tight may result in corns, hammertoes, and ingrown toenails. People can avoid such problems by taking special care when buying shoes, especially children's shoes. Most children outgrow their shoes within a few months.

Shoes should have a space of $\frac{1}{2}$ to $\frac{3}{4}$ inch (13 to 19 millimeters) between the tip of the big toe and the shoe. Most people have one foot larger than the other, and so both feet should be fitted. A person should walk around

Some shoes of the past

Throughout history, fashion has often determined the style of men's and women's shoes. The desire of people to be fashionable has led to many unusual kinds of shoes.

WORLD BOOK illustrations by David Cunningham



while trying on new shoes to ensure a comfortable fit.

Some people wear certain fashionable shoes even though these shoes are uncomfortable and can hurt the feet. For example, high heels can cramp the toes by pushing the feet forward. Pointed shoes also crowd the toes. Shoes with hard, thick soles can prevent flexible movement. Hot feet can result from shoes that do not *breathe* (allow foot moisture to escape). Some synthetic materials do not breathe as well as leathers.

History. No one knows when people first began to wear shoes. The first foot coverings worn in cold regions were probably baglike wrappings made of animal fur. The first known footwear used in warm surroundings consisted of sandals made of plant fibers or leather. The ancient Egyptians wore such sandals as early as 3700 B.C., and the ancient Greeks and Romans also wore sandals. In China, people wore wooden-soled shoes and cloth shoes thousands of years ago.

Throughout history, people have worn shoes not only for protection but also for decoration and to indicate social status. Shoe styles have gone in and out of fashion, just as they do today. For example, the fashion in women's shoes changed to rounded toes in the 1500's, low heels by the late 1500's, and high heels in the 1600's.

The Indians of North America made moccasins of animal skins. The Europeans who settled in the New World wore sturdy leather shoes most of the time, but some colonists also wore moccasins.

Until the mid-1800's, despite the many changes in shoe styles, shoemaking itself involved chiefly the use of simple hand tools. Most people wore homemade shoes or bought shoes from a shoemaker who lived nearby or traveled from house to house. Improved sewing machines were developed in the mid-1800's, and shoemaking became a factory operation. These machines had special devices to stitch shoe parts that previously had required nailing or stitching by hand.

In 1882, Jan Ernst Matzeliger, a worker in a Massachusetts shoe factory, invented the shoe-lasting machine. This and other new shoemaking machines led to the mass production of shoes by 1900. The mass production of footwear brought a great reduction in the price of these products. Today, many shoe-manufacturing operations are automated. For example, shoes may be designed on a computer. In addition, components may be cut by a laser and stitched by computer-controlled stitchers. Such improvements enable manufacturers to respond to style changes quickly and with reduced costs. Critically reviewed by Footwear Industries of America

See also **Leather; Matzeliger, Jan Ernst; Moccasin.**

Shoebill is a large bird that many scientists believe is related to the stork. It is sometimes called *whale-headed stork.* Shoebills live in Africa on marshes from the Upper Nile to Uganda and Congo (Brazzaville). The bird stands up to 4 feet (1.2 meters) tall. It is ashy-gray and is named for its enormous bill. When disturbed, it snaps its bill open and shut rapidly, making a loud rattling sound.

© Tom McHugh, Photo Researchers

Shoebill

The shoebill has long legs. It wades in shallow water, where it feeds on fish. It uses its huge bill to dig African lungfish out of the mud in the dry season. The shoebill flies with its neck in the shape of an *S,* its long legs trailing behind. Shoebills live in pairs. They nest on the ground where they build a large platform of reeds lined with grass. The female bird lays one or two rough-shelled white eggs. David M. Niles

Scientific classification. The shoebill makes up the shoebill family, Balaenicipitidae. Its scientific name is *Balaeniceps rex.*

Shoemaker, Bill (1931-), ranks among America's greatest jockeys. During his racing career from 1949 to 1990, Shoemaker rode 8,833 winners in 40,350 races and won purses totaling more than $120 million. In 1956, he became the first jockey to win over $2 million in purses in one year. He rode the winning horse in the Kentucky Derby in 1955, 1959, 1965, and 1986.

William Lee Shoemaker was born Aug. 19, 1931, in Fabens, Texas. After his retirement as a jockey, he trained race horses and began a career as an author of detective stories with a horse racing background. In 1991, he was paralyzed in an auto accident. William F. Reed

Shoemaker, Eugene Merle (1928-1997), was an American geologist and astronomer. He almost singlehandedly founded *astrogeology,* the study of the geology of the planets and their satellites. His research alerted the public to the danger of Earth's being hit by a comet or an asteroid.

In the late 1950's, Shoemaker became interested in impacts of asteroids and comets with planets and satellites. He proved that Meteor Crater in Arizona was formed when an asteroid struck Earth. In the early 1960's, he began to study the craters of the moon. He also worked with the astronauts who were to go to the moon.

From 1973 to 1994, Shoemaker conducted photographic surveys of the sky. His early surveys were conducted with the American astronomer Eleanor Helin. Shoemaker's wife, Carolyn, later assisted with the surveys. Shoemaker and his wife discovered 32 comets and many asteroids. In 1993, they and the Canadian-born American astronomer David H. Levy discovered Comet Shoemaker-Levy 9, which in 1994 collided with Jupiter.

Shoemaker was born on April 28, 1928, in Los Angeles. He received a bachelor's degree in geology from California Institute of Technology (Caltech) in 1947 and a master's degree from Caltech in 1948. In 1960, he received a doctor's degree from Princeton University. During most of the time from 1948 to 1993, he served with the United States Geological Survey. From 1968 to 1985, he was also a professor of geology at Caltech. He died on July 18, 1997. David H. Levy

See also **Jupiter** (The impact of Comet Shoemaker-Levy 9); **Meteor Crater.**

Shogun, *SHOH guhn,* was the title of the warrior rulers who led Japan from the late 1100's to the mid-1800's. *Shogun* means *great general* in Japanese. Japan's emperor had first given this title to officers sent to fight tribes in the northern frontier region late in the A.D. 700's.

In 1192, the emperor gave the title *shogun* to the military leader Yoritomo of the Minamoto family. Yoritomo established a *shogunate* (warrior government) in Kamakura. This shogunate, which lasted until 1333, shared civil and military rule with the imperial court at Kyoto.

The Ashikaga family, a branch of the Minamoto family, established a shogunate in the Muromachi district of Kyoto in 1338. The Ashikaga shoguns were weak and unable to maintain control. This period was marked by battles among the warrior class, called *samurai.*

In 1603, Ieyasu of the Tokugawa family founded the most powerful shogunate, in Edo (now Tokyo). The shogunate lasted until 1867, when the shogun resigned and returned his powers to the emperor. Jeffrey P. Mass

See also **Minamoto Yoritomo; Samurai; Tokugawa Ieyasu.**

Sholem Aleichem, *SHOH lehm ah LAY kehm* (1859-1916), was the pen name of Sholem Rabinowitz, the most widely read of all Yiddish writers. He wrote humorous short stories, novels, and plays about life in the *Pale of Settlement.* Russian Jews were required to live in this area of western Russia until 1917. Sholem Aleichem's works also deal with Jewish immigration to the United States. His technique of "laughter through tears" emphasized the dignity, generosity, and shrewd self-appraisal of his poverty-stricken characters.

Major works include the four series of stories *Menakhem-Mendl* (1892), *Motl the Cantor's Son* (1907), *The Railroad Stories* (1911), and *Tevye the Dairyman* (1911). The Tevye stories inspired the musical *Fiddler on the Roof* (1964). His best-known play, *It's Hard to Be a Jew,* was written in 1914. Sholem Aleichem was born near Kiev, Ukraine (then a part of the Russian Empire). He immigrated to the United States in 1914 and died there on May 13, 1916. Eugene V. Orenstein

Sholes, *shohlz,* Christopher Latham, *LAY thuhm* (1819-1890), an American inventor and journalist, helped develop the first practical typewriter. Sholes, Carlos Glidden, and Samuel W. Soulé designed the typewriter in 1867 and patented it in 1868. Glidden and Soulé sold their interests to Sholes and his new partner, James Densmore. They improved the typewriter and began to manufacture it in 1870. But they were unable to sell it. In 1873, Sholes and Densmore gave E. Remington and Sons a contract to make it. Sholes later sold most of his interest in the typewriter. Sholes was born on Feb. 14, 1819, near Danville, Pennsylvania. He was a Wisconsin newspaper editor and served in the Wisconsin state Legislature. He died on Feb. 17, 1890. See also **Typewriter** (History). George H. Daniels

Sholokhov, *SHAW lah kawf,* Mikhail, *myih kuh EEL* (1905-1984), a Soviet writer, received the Nobel Prize in literature in 1965. Mikhail Alexandrovich Sholokhov was born on May 24, 1905, in Veshenskaya, a Cossack village in southwestern Russia. He won fame for novels and stories describing the life and people of his native region. His best-known work is the four-volume historical novel *The Quiet Don* (1928-1940). This epic story describes the effects of the Russian Revolution of 1917, and of the civil war that followed, on the lives of the Don Cossacks. Sholokhov also wrote *Virgin Soil Upturned* (1932, 1955-1960), a two-volume novel about the problems of Don Cossacks living on collective farms. His early works include the short-story collections *Tales of the Don* (1925) and *The Azure Steppe* (1926). He died on Feb. 21, 1984. See also **Russian literature** (The period of socialist realism). Anna Lisa Crone

Shooting. See **Archery; Firearm; Gun; Hunting.**

Shooting star. See **Meteor.**

Shoplifting is the crime of stealing merchandise from a store while pretending to be a customer. Shoplifting costs store owners money and results in higher prices for customers. Most shoplifters have enough money to pay for the items they steal. Some shoplifters do not feel guilty about shoplifting because they believe that stores overcharge and can easily afford such small losses.

Before the mid-1900's, various laws made it difficult to convict shoplifters. For example, salespeople had to let a shoplifter leave the store to prove the person had intended to steal. In many cases, the defense attorney con-

vinced the jury that a shoplifter had merely forgotten to pay for the merchandise. Between the 1930's and the 1960's, most states enacted special laws to deal with shoplifting. Many of these laws provide that any person who conceals store merchandise will be assumed to be stealing it. The laws also allow salespeople to detain a suspect long enough to investigate the situation.

Despite tougher laws, few shoplifters are caught or punished. Most stores, in an effort to stimulate sales, display merchandise openly and encourage shoppers to examine it. These policies hamper the detection of shoplifters. To curb shoplifting, some merchants have installed closed-circuit television, electronic scanners, and other security devices. William E. Cobb

Shopping center is a group of stores built as a unit with on-site parking. In large shopping centers, the stores may be arranged around an open pedestrian area called a *mall.* Some malls are enclosed so that people can shop comfortably in any kind of weather. Large shopping centers may also contain such facilities as hotels, restaurants, a library, banks, a post office, medical clinics, theaters, and parks.

Most shopping centers are owned by a single firm and rented out to tenants. The firm works to make the center a place where the tenants will succeed. Tenants generally pay a base rent, plus a percentage of their earnings, called *overage.* The profits of shopping center owners come largely from overage. Thus, the center will succeed only if the tenants are successful.

The owner seeks to attract shoppers to the center to create a busy market setting for the tenants. The firm chooses a site that is easily reached by the population it wants to serve. When the site is chosen, the firm puts up buildings with an ample parking area. The owner rents space to a mix of stores that, as a group, will appeal to the population the owner wants to attract.

When the center opens, the owner makes sure that the common areas are kept clean and that the buildings and grounds are maintained. The owner provides for security and fire protection. The owner also may help staff and run a merchants' association. The association promotes cooperation among the merchants and plans and publicizes special sales and promotions.

Marketplaces that lease space to traders have existed since ancient times. But the modern shopping center, designed to be accessible to automobiles, developed in the United States. Many people consider the first shopping center to be the Roland Park Shopping Center, built in Baltimore in 1896. Fewer than a dozen shopping centers existed in the nation when World War II ended in 1945. But after the war, the idea caught on and spread worldwide. Spencer Heath MacCallum

Short story is a work of fiction that is shorter than a novel or novelette. Most can be read at one sitting.

The short story is one of the oldest forms of literature. As early as 3000 B.C., brief fictional tales were written down in Egypt. The Bible contains short stories called *parables,* which teach moral lessons.

Some of the most famous short stories ever written make up two collections that appeared late in the Middle Ages. The *Decameron* (about 1349-1353) is a collection of 100 tales by Giovanni Boccaccio, an Italian writer. *The Canterbury Tales* (about 1385-1400) is a book of 24 stories by Geoffrey Chaucer, an English poet.

During the 1800's, many writers began to consider the short story as a separate form of literature. Edgar Allan Poe, an American author and literary critic, was perhaps the first important writer to analyze short stories as a distinct literary form. In some of his writings, Poe discussed the dramatic effects, such as fear and surprise, that could be achieved in a short story. The first book about short-story writing was *The Philosophy of the Short-Story* (1901) by Brander Matthews, an American critic. This book contained many of Poe's ideas.

Short-story writers have developed a number of literary techniques, including the *surprise ending* and *epiphany.* Most surprise endings involve an unexpected event or a revealing explanation. Such endings were the specialty of O. Henry, an American short-story writer of the late 1800's and early 1900's. He used surprise endings in "The Furnished Room" (1904), "The Gift of the Magi" (1905), and many other tales. Epiphany is a sudden comment, incident, or symbol that can be used at any point in a story to explain the meaning of a complex event. James Joyce, an Irish author of the early 1900's, created this technique. He included it in a collection of short stories called *Dubliners* (1914).

Some writers of short stories concentrate on the events of ordinary life instead of emphasizing dramatic action. Anton Chekhov, a Russian writer, used such an approach in many stories, including "The Party" (1888) and "The Lady and the Dog" (1899). A number of later writers followed his style, including the American authors John Cheever and John Updike. American short-story writers such as Ann Beattie, Raymond Carver, and Joyce Carol Oates have used the form to record breakdowns in modern life. Marcus Klein

Related articles in *World Book* include:

Boccaccio, Giovanni
Canterbury Tales
Chekhov, Anton
Henry, O.
Parable
Poe, Edgar Allan

Additional resources

Magill, Frank N., ed. *Masterplots II, Short Story Series.* 10 vols., including supplement. Salem Pr., 1986, 1996.

Wilson, Kathleen, ed. *Short Stories for Students.* Gale Research, 1997- . Multivolume work.

Short waves are radio waves that have wavelengths shorter than those of waves used in amplitude modulation (AM) broadcast transmissions. Wavelength is the distance between successive wave crests. Wavelength is related to frequency. As frequency increases, wavelength decreases. Short waves have frequencies higher than 1.7 *megahertz.* One megahertz (MHz) equals 1 million *hertz* (cycles per second).

Short waves carry frequency modulation (FM) radio broadcasts, television signals, and transoceanic telephone conversations. Short-wave radios are used by airplane pilots, amateur radio operators, police officers, taxi drivers, and others to send and receive messages.

Short-wave frequencies are divided into bands. The *medium frequency* band includes frequencies up to 3 MHz. The *high frequency* band ranges from 3 to 30 MHz; the *very high frequency* band, from 30 to 300 MHz; and the *ultrahigh frequency* band, from 300 to 3,000 MHz (see **Very high frequency waves**). Hugh D. Young

See also **Microwave; Radio, Amateur.**

Shortening. See **Butter; Lard; Margarine; Vegetable oil.**

Shorthand is a method of writing rapidly, using symbols or letters to represent the sounds of words. In shorthand, a person writes only what he or she actually hears, regardless of the spelling of a word. For example, the word *people* becomes *pepl* in shorthand. Other short cuts include using a symbol or a combination of symbols or letters to represent whole words or entire phrases of several words.

Shorthand is used chiefly to take dictation. Most people speak at a rate of about 140 words a minute. But a stenographer can take most dictation by writing shorthand at a rate of 80 words a minute. Some stenographic jobs, however, require speeds of 120 or more words a minute. Court reporters must be able to take down conversation at a rate of at least 200 words a minute. The world record for writing shorthand in a contest is held by Martin Dupraw, an American court reporter. In 1927, using the Gregg method of shorthand, Dupraw took down testimony at a rate of 282 words a minute for five minutes.

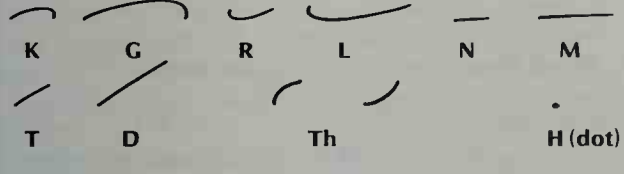
Hundreds of shorthand systems have been developed. The *Gregg* and *Pitman* methods are the best-known systems using symbols. The *Thomas Natural* system, a newer method, is not used so much as the others. *Speedwriting* is the most common of the shorthand systems that use longhand letters instead of symbols (see Speedwriting). Several shorthand machines have also been developed. The *Stenograph* is the most widely used of these machines.

Gregg shorthand

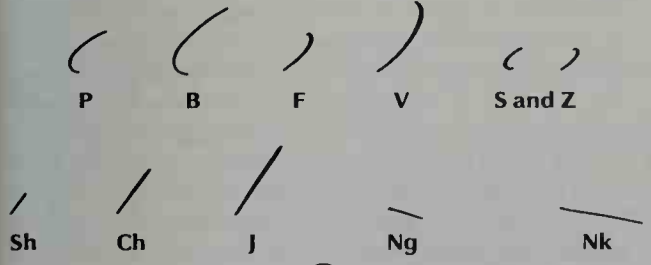
The Gregg method was invented by John Robert Gregg, an educator born in Ireland. It is the most widely used shorthand system in the world. Gregg published his first book, *Light-Line Phonography,* in England in 1888. He later promoted his system in the United States. The symbols in the Gregg system are based on longhand strokes and flow along in the same smooth style as longhand writing.

Consonants. Many characters representing consonants in the Gregg system appear in pairs and differ only in length.

Written forward:



Written downward:

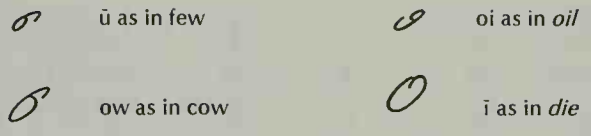


Vowels. A large circle, ○, is used to represent the sounds of the vowel *a*: ă as in *cat;* ä as in *calm;* ā as in *cane.*

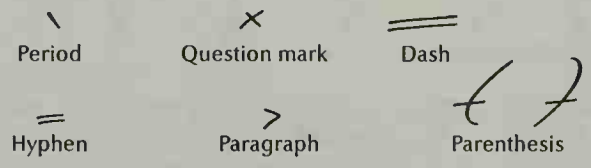
A small circle, ∘, is used for the following sounds: ĭ as in *hit,* ĕ as in *hen,* and ē as in *greet.*

A hook, ∪, is used to indicate the following sounds: ŏ as in *rot,* aw as in *raw* and *bought,* and ō as in *wrote.*

Diphthongs:

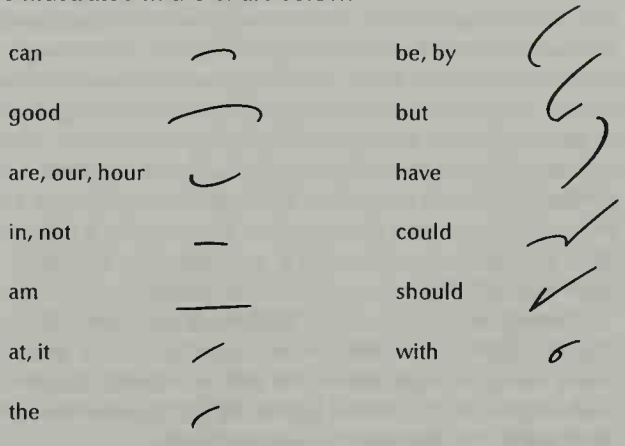


Punctuation:



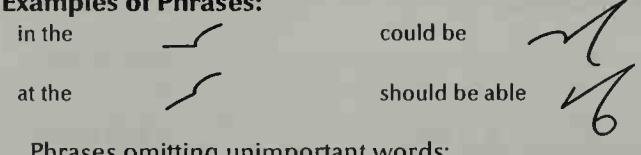
A different hook, ∩, is used for these sounds: ŭ as in *duck;* o͝o as in *took;* o͞o as in *pool.*

Brief forms. A person studying the Diamond Jubilee Edition of Gregg shorthand learns the symbols and memorizes 129 *brief forms* that represent common words. Examples of the most frequently used symbols are illustrated in the chart below.

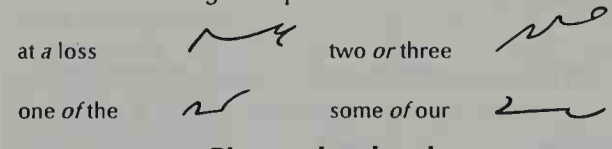


Phrasing. All shorthand systems include many standard phrases. Most students learn these phrases from a textbook. Most writers also work out their own phrases for expressions used often by their employer.

Examples of Phrases:



Phrases omitting unimportant words:

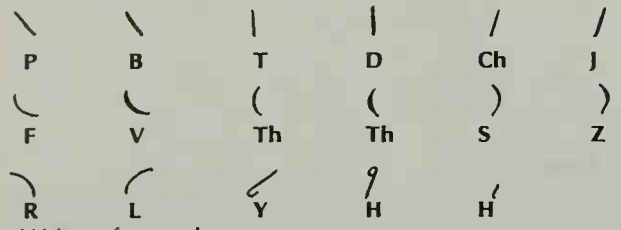


Pitman shorthand

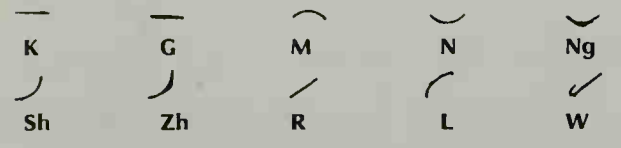
The Pitman method was invented by Isaac Pitman, an Englishman, in the 1830's. His first shorthand book was published in England in 1837. Pitman shorthand is characterized by the shading of strokes. Some strokes are light and others are heavy or dark. In Pitman shorthand, the position of the symbol *above, on,* or *through* the line further determines the meaning of the word.

Consonants. Many similar-sounding consonants are represented by the same symbol. The shading of the symbol indicates differences in sound.

Written downward:



Written forward:



Circles: S Z

Vowels. When the first vowel in a word has the sound of ă, ah, ŏ, or aw, the outline is written *above* the line. When the first vowel has the sound of ĕ, ā, ŭ, or ō, the outline is written *on* the line. When the first vowel has the sound of ĭ, ē, o͝o, or o͞o, the outline is generally written *through* the line. But there are some exceptions to this rule for writing outlines through the line.

When placed near the beginning of a consonant stroke, a light dot expresses the sound of ă as in *sat,* a heavy dot expresses the sound of ah as in *car,* a light dash expresses the sound of ŏ as in *got,* and a heavy dash expresses the sound of aw as in *talk.*

When placed close to the middle of a consonant stroke, a light dot expresses the sound of ĕ as in *get,* a heavy dot expresses the sound of ā as in *mate,* a light dash expresses the sound of ŭ as in *trust,* and a heavy dash expresses the sound of ō as in *low.*

When placed close to the end of a stroke, the sound of ĭ as in *sit* is shown by a light dot, the sound of ē as in *tea* by a heavy dot, the sound of o͝o as in *foot* by a light dash, and o͞o as in *food* by a heavy dash.

Diphthongs:

v i as in *buy*

ʌ ow as in *out*

ɔ oi as in *boy*

ᵕ u as in *beauty*

Punctuation:

Period

Question mark

Exclamation point

Hyphen

Dash

Parenthesis

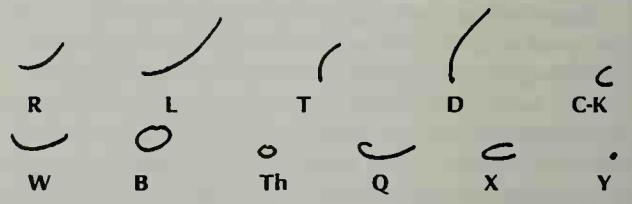
Short forms. Pitman shorthand has 204 *short forms.* Like the Gregg brief forms, these represent frequently used words and phrases.

Thomas Natural shorthand

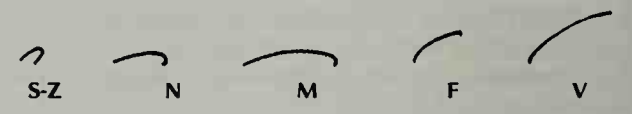
The Thomas Natural system was invented in the 1930's by Charles A. Thomas, an American shorthand teacher. Thomas' first textbook appeared in 1935. It was designed to provide a simpler symbol system. However, the Thomas Natural system never became widely used. It has only 12 word forms. They correspond to brief forms and short forms. Other words may be shortened by writing the first consonant and other major sounds.

Consonants have definite symbols.

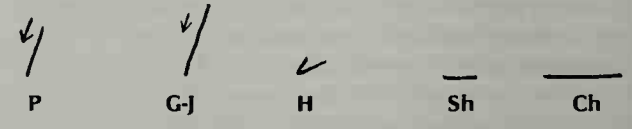
Written counterclockwise:



Written clockwise:



Straight-line strokes:



Vowels. The vowel following the first consonant of a word is expressed automatically by simply placing the base of the consonant stroke *above* the line to express *a, on* the line to express *e* and short *i,* and *below* the line to express *o, oo,* and *u.* Vowels at the beginning of words are expressed in the following manner:

(Long *i* is always written in this manner.)

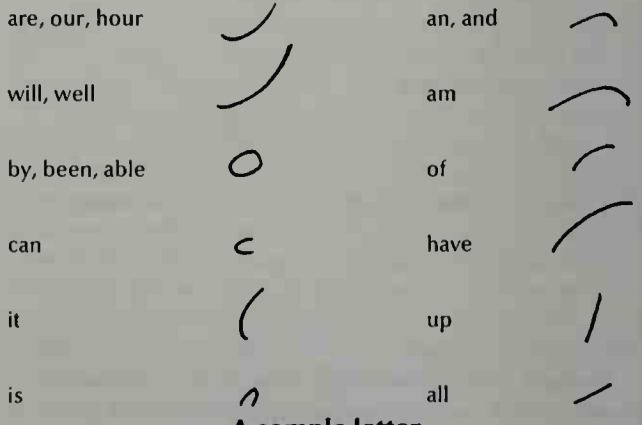
Punctuation:

Period

Question mark

Paragraph

Word signs. These are the 12 memory forms:



A sample letter

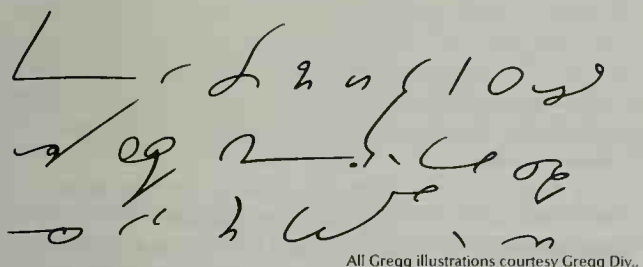
Here is a letter written in the two leading systems of symbol shorthand.

Gentlemen:

The back issue of your publication, which I recently requested, arrived this morning. Please accept my thanks for your promptness.

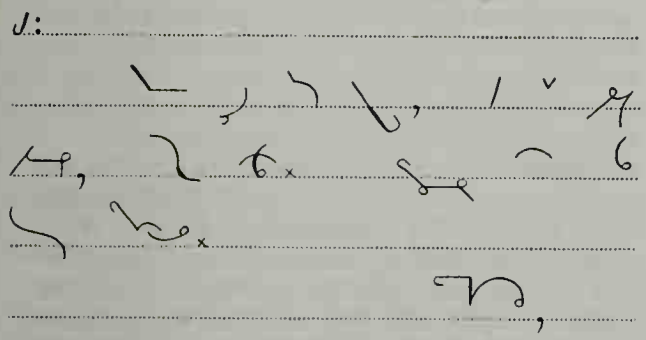
Cordially yours,

Gregg:



All Gregg illustrations courtesy Gregg Div., McGraw-Hill Book Co., Inc.

Pitman:



All Pitman illustrations courtesy Pitman Publishing Corp.

History

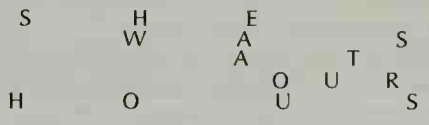
Marcus Tullius Tiro, a secretary to the Roman orator Cicero, invented a shorthand system about 50 B.C. During the A.D. 700's, the art of shorthand seemed to disappear. It was revived in England in 1588, when Timothy Bright published his *Characterie: an Art of Short, Swift, and Secret Writing by Character.* This was followed by Peter Bale's *Brachygraphy.* In 1602, John Willis published *The Art of Stenography,* the first attempt at a genuine alphabetical system. Pitman's book in 1837 brought shorthand into worldwide use. Gregg published his book in 1888. Gregg shorthand has been adapted to many languages. Jerome P. Edelman

See also **Gregg, John R.; Shorthand machine; Speedwriting.**

Shorthand machine is used to record speech rapidly and accurately. The machine has 21 lettered keys. Any number of letters may be struck at one time. The operator produces numbers by striking a numeral bar and a key bearing the desired number. The numeral bar corresponds to the shift key of a typewriter.

The keyboard is arranged so that the fingers of the left hand print the beginning consonants of a word, the right hand prints the concluding consonants, and the thumbs print the vowels. The letters C, I, J, M, N, Q, V, X, Y, and Z are omitted. They are represented by combinations of other letters that are printed by a single stroke. For example, *M* is represented by the letters *PH.* The letters P, R, S, and T are in both the left-hand and the right-hand positions on the keyboard.

A shorthand machine operator writes by sounds, much like writers using other shorthand systems. Thus, the operator omits all letters of a word that are not actually pronounced. Many words and phrases can be written with single strokes. The operator writes multistroke words one syllable at a time. The letters are printed on a narrow paper pad that moves automatically, a line with each stroke. Anyone familiar with this method can easily transcribe the notes. The sentence *She was at our house* would be written like this:



There are several different types of shorthand machines, such as the Stenograph and the Stenotype. Shorthand machines are mainly used for recording speeches and court testimony. Ward Stone Ireland, a stenographer and court reporter from Dallas, Texas, invented the first shorthand machine, the Stenotype, in 1910.

Eileen Feretic

See also **Shorthand.**

Shortsightedness. See **Nearsightedness.**

Shortwall mine. See **Coal** (The longwall system).

Shoshone Indians, *shoh SHOH nee,* also spelled Shoshoni, once lived in the desert area of what is now eastern Nevada, southern Idaho, and western Utah. The first white settlers in this region, known as the Great Basin, sometimes called the Shoshone "Snake" Indians. Sacagawea, a Shoshone woman, became famous for her role as an interpreter with the Lewis and Clark Expedition (see **Sacagawea**).

The Shoshone lived on some of the most barren land in the United States. They formed small, isolated family groups. These groups constantly moved from place to place in search of seeds, roots, fish, birds, and small animals such as rabbits. The Shoshone planned their journeys so that they could collect each type of plant as it ripened and visit each animal's favorite haunt. They returned to the same areas once each year. One group referred to another according to the main food of a region. There were Seed Eaters, Rabbit Eaters, and so on. If people had an abundance of food, families gathered together where the winter was mild to form a village. They spent much of the time singing, dancing, and telling stories.

The Shoshone acquired horses from the Spaniards, and became buffalo hunters like the Plains tribes. Well-known leaders of these Shoshone included the chieftains Pocatello and Washakie (see **Washakie**). During the 1800's, the Shoshone moved to Indian reservations. According to the 2000 U.S. census, there are about 7,700 Shoshone. Many Shoshone now live as ranchers and farmers in Wyoming, Nevada, Idaho, and Utah.

Allen P. Slickpoo, Sr.

See also **Lewis and Clark Expedition** (West to the Rockies; picture).

Shostakovich, *SHAHS tuh KOH vihch,* **Dimitri,** *dih MEE tree* (1906-1975), was the most important Russian composer whose musical education and career took place entirely in the Soviet Union. His major works are 15 symphonies and 15 string quartets. He also wrote concertos, songs, motion-picture scores, ballets, and

operas. His most popular compositions include the lively "Polka" from the ballet *The Golden Age* (1930).

Shostakovich based his musical style on the Russian nationalism of the 1800's demonstrated by composer Peter Ilich Tchaikovsky and a group of Russian composers known as The Five. Shostakovich also added influences from Western music. His monumental symphonies owe much to the late romantic symphonic style of the Viennese composer Gustav Mahler. Shostakovich added his own wit and humor, rhythmic vitality, mastery of the orchestra, and intensity of expression.

Shostakovich was born Sept. 25, 1906, in St. Petersburg (later named Petrograd and then Leningrad). He entered the Petrograd Conservatory in 1919. For his graduation, he wrote his Symphony No. 1 (1925), which won international acclaim. By the early 1930's, Shostakovich was writing in a style that authorities eventually declared unacceptable for a Soviet composer. In 1936, they denounced his opera *Lady Macbeth of Mtsensk* (1932) as "chaos instead of music." Between 1956 and 1963, Shostakovich revised this opera as *Katerina Ismailova,* one of his finest works. In 1937, he composed his Symphony No. 5, which restored him to favor with the government.

In 1941, Shostakovich wrote his Symphony No. 7. He dedicated it to the city of Leningrad, which was being blockaded by the Germans during World War II. In 1948, the government again censured Shostakovich's music, along with works by other leading Soviet composers. After the death of Soviet dictator Joseph Stalin in 1953, Shostakovich felt more at liberty to compose as he pleased. Several of his late large-scale works reflect Russian history of the 1900's. Edward V. Williams

Additional resources

Fay, Laurel E. *Shostakovich: A Life.* Oxford, 2000.
Shostakovich, Dmitri. *Testimony: The Memoirs of Dmitri Shostakovich.* 7th ed. Limelight, 2000.

Shot-put is a test of strength in track and field meets. In ancient times, athletes used a heavy stone as the *shot.* Today, athletes use a metal ball. Men use a 16-pound (7.26-kilogram) shot, high school athletes use one of 12 pounds (5.44 kilograms), and women use one that weighs 8 pounds 13 ounces (4 kilograms).

Success in shot-putting depends upon ability to get the whole force of the body behind the heave. The put is made from a circle 7 feet (2.1 meters) across. An arc-shaped stopboard forms the front of the circle.

Most shot-putters use either the *glide* or the *spin* technique. Every thrower starts at the back of the circle facing the back. The thrower balances the shot in the hand, cradling it against the neck. In the glide, he or she then hops, or glides, toward the front of the circle as the body turns until the leading foot is near the stopboard. As the athlete propels the shot, the arm thrusts out in a long follow-through. In the spin, the thrower turns or spins to gain momentum, rotating 1 $\frac{1}{2}$ times as he or she steps toward the front of the circle. While completing a turn near the front of the circle, the thrower pushes the shot out. The measurement of the put is made from the nearest edge of the first break of ground to the nearest point on the inside edge of the shot-put circle.

Michael Takaha

For shot-put championship figures, see the *tables* with **Track and field** and **Olympic Games**.

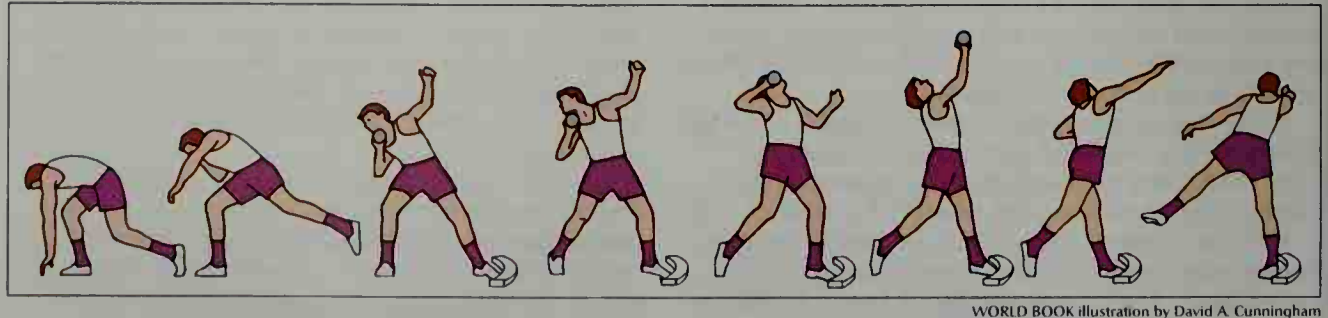
Shot tower is a structure used to make small shot for firearms. In colonial days, shot towers were wooden or brick towers 50 to 100 feet (15 to 30 meters) high. People poured melted lead through a vessel at the top of the tower that had holes in it. As each piece of lead dropped, it formed a round ball. It cooled in this shape when it landed at the bottom in a vessel containing cold water. Today, most shot is made in towers that are up to 190 feet (58 meters) high. Douglas M. Wicklund

Shotgun is a shoulder gun that fires a cartridge that contains a powder charge and a load of metal pellets, called *shot.* The shot spreads over a wide area. This makes it easier to hit a moving target with a shotgun than with the single bullet from a rifle or a pistol. The shotgun is chiefly a hunting gun. Small shotgun pellets are called *bird shot.* Larger ones, called *buckshot,* are used to shoot such animals as deer.

The caliber of a shotgun is measured by *bore,* or *gauge.* The weight of the lead shot required to fit the muzzle of the gun is the standard of measurement for the bore. If a bullet weighing $\frac{1}{12}$ pound (38 grams) fits the bore, the shotgun is called a 12-bore, or a 12-gauge, gun. Popular gauges are 10, 12, 16, 20, 28, and .410.

The amount of spread in the shot is controlled by the *choke.* If a barrel will put 70 percent of its shot charge in a 30-inch (76-centimeter) circle at 40 yards (37 meters), it is called *full choke. Modified choke* will deliver about 60 percent; *improved cylinder* about 50 percent. A full choke 12-gauge gun will kill ducks that are about 60 to 65 yards (55 to 59 meters) away.

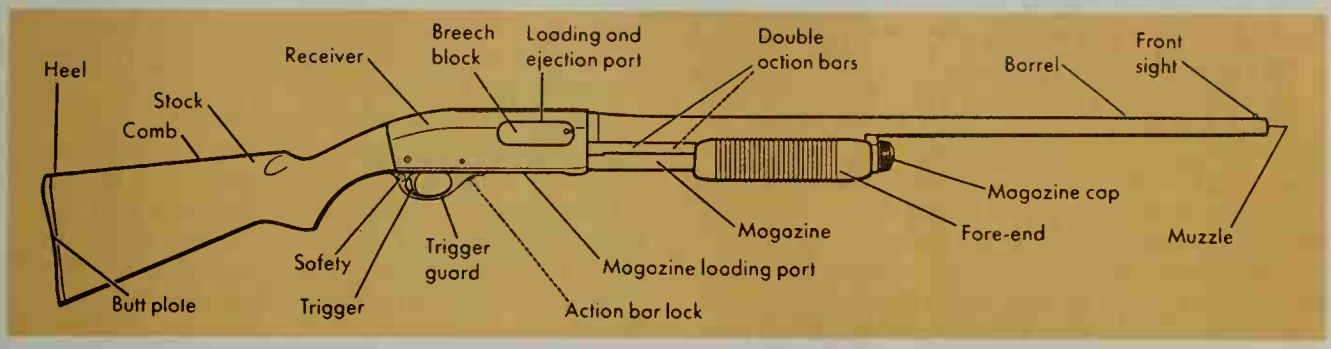
The first shotgun, developed in 1537, was loaded with small shot instead of one round ball. In 1831, Augustus Demondion patented a cartridge that held small shot. Modern shotguns are single barrels, double barrels, or



WORLD BOOK illustration by David A. Cunningham

A shot-putter holds the shot against his neck with one hand and extends the other arm to maintain balance. This drawing shows how the athlete swings one leg for balance and momentum. Then, after gliding across the ring, he pushes the shot away to release it.

Main parts of a pump action shotgun



single barrels with automatic repeating magazines that hold several cartridges. Repeating shotguns are popular in the United States with hunters as well as with many law enforcement officers. Ronald A. Ogan

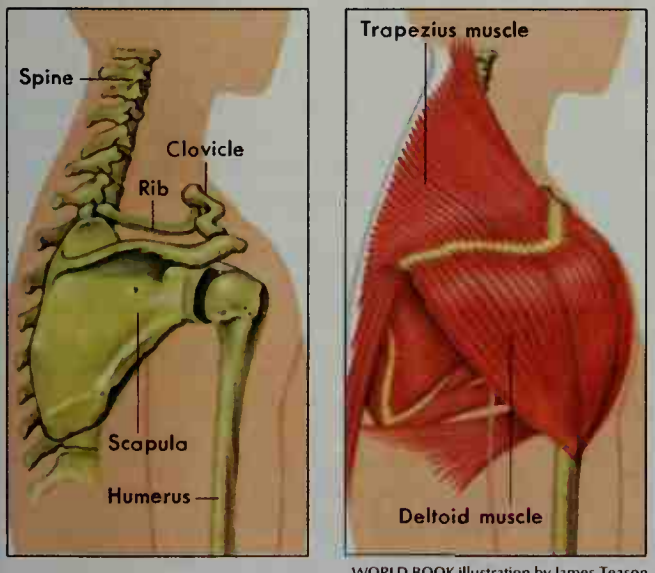
See also **Ammunition** (with diagram).

Shoulder is the part of a person's body between the neck and the arm. It includes bones and muscles that attach the arm to the body. The shoulder consists of three bones—a broad, flat *scapula* (shoulder blade), the slender *clavicle* (collarbone), and the *humerus* (bone of the upper arm). The chief muscles are the *deltoid muscle* and the *trapezius muscle*.

The shoulder is the most mobile joint in the body. The humerus has a round head that fits into a shallow depression of the scapula to form the shoulder joint. Another joint formed near the tip of the shoulder by the clavicle and the scapula permits the scapula to twist. Movement also occurs between the scapula and ribs.

The shoulder muscles also help the arm move. The deltoid muscle raises the upper arm. The trapezius muscle helps rotate the scapula. The combined action of the joints with support from the muscles allows for free movement in all directions.

The shoulder joint can be dislocated more easily than any other joint. Many athletes dislocate shoulders by falling on an outstretched arm or being pushed hard from behind. Leslie S. Matthews



WORLD BOOK illustration by James Teason

The shoulder consists of three bones, *left*, the *clavicle*, *scapula*, and the *humerus*, the upper arm bone. The bones form a ball-and-socket joint surrounded by muscles, *right*. The *deltoid muscle*, one of the largest shoulder muscles, helps move the upper arm. The *trapezius muscle* helps rotate the scapula.

See also **Collarbone; Human body** (picture); **Joint**.

Shoup, *shoop,* **George Laird** (1836-1904), was the first governor of Idaho. He volunteered for the Union Army during the American Civil War (1861-1865) and rose to the rank of colonel. He helped found Salmon, Idaho, in 1866, and was successful as a merchant there. He served in the territorial legislature and was appointed territorial governor by President Benjamin Harrison. When Idaho was admitted to the Union in 1890, Shoup was elected governor. But he resigned to serve as a Republican in the United States Senate from 1890 to 1901. Shoup campaigned for improved treatment of American Indians. He was born in Kittanning, Pennsylvania. Edward A. Lukes-Lukaszewski

Shoveler is the name of four species of small, blue-winged ducks with spoon-shaped bills. Shovelers breed in temperate parts of the world. They measure about 19 inches (48 centimeters) long. With its spoonbill, a shoveler gathers and filters tiny *invertebrates* (animals without backbones) from shallow waters. It feeds as it swims with its bill just below the water surface. The bill's edges act as a strainer to trap food. Breeding male *northern shovelers* have dark green heads and white breasts. Females are brown. Northern shovelers breed in North America, Europe, and Asia. They winter in northern Africa and Central America. See also **Bird** (picture: Birds of inland water and marshes). Rodger D. Titman

Scientific classification. Shovelers are in the family Anatidae. The northern shoveler is *Anas clypeata*.

Shrapnel was a type of artillery shell invented by Lieutenant (later, Lieutenant General) Henry Shrapnel. The shell contained a number of balls and a charge of powder that burst the shell. The British Army used the first shell of this type in Suriname in 1804. During World War I (1914-1918), shrapnel was considered one of the most reliable, effective antipersonnel shells. Since World War II (1939-1945), the word commonly refers to steel fragments of the shell casing hurled by an explosive charge, though some shells filled with metal fragments are still used. See also **Ammunition; Artillery**. Frances M. Lussier

Shreveport, *SHREEV pawrt,* Louisiana (pop. 200,145), is one of the largest cities in the state. Shreveport, a major center of industry and trade, lies on the Red River, in northwestern Louisiana. Shreveport and Bossier City form a metropolitan area with 392,302 people. For location, see **Louisiana** (political map).

The city was named for Henry M. Shreve, a trader and steamboat builder. Shreve opened the Red River to navi-

gation in the 1830's by clearing it of a logjam that was more than 160 miles (257 kilometers) long. Shreveport has a mayor-council government and is the *parish* (county) seat of Caddo Parish.

Shreveport is the home of Centenary College of Louisiana and branches of Louisiana State University and Southern University. Cultural attractions in the city include the Louisiana State Exhibit Museum and the R. W. Norton Art Gallery. The Civic Theater, Convention Hall, and the Barnwell Garden and Art Center are on the riverfront. Shreveport hosts the annual Louisiana State Fair and the Holiday-in-Dixie spring festival.

Shreveport has about 260 manufacturing plants. The city's industries include the production of fabricated metals, glassware, telephone equipment, wood products, chain saws, trucks, and steel castings. Agricultural products include beef cattle, cotton, and timber. A number of railroads and airlines serve the city. Shreveport has one daily newspaper—the *Times*.

Caddo Indians lived in what is now the Shreveport area before white settlers arrived. In 1834, English and Scotch-Irish families began to move there from the Carolinas, Georgia, Tennessee, and Virginia. They set up a farming community on the site because of its fertile soil and its location above the river's flood level.

Shreveport was incorporated in 1839. It served as the Confederate state capital from 1863 to 1865. The cotton industry provided most of the town's income during the 1800's. Then, in 1906, oil and natural gas were discovered in nearby Caddo Lake. Cotton and oil operations, plus the expansion of other industries, brought rapid growth to Shreveport during the first half of the 1900's.

In 1994, the Red River Navigation Project was completed. The project deepened the Red River and provided industrial areas of Shreveport with a water link to the Mississippi River and the Gulf of Mexico.

Vaughan B. Baker

For the monthly weather in Shreveport, see **Louisiana** (Climate). See also **Louisiana** (picture).

Shrew, *shroo,* is a small animal that looks like a sharp-nosed mouse. Some shrews are among the smallest known mammals. The tiniest shrews weigh as little as a United States penny. Shrews live in both the Eastern and the Western hemispheres. They make their homes in fields, woodlands, gardens, and marshes.

Shrews are often mistaken for mice because of their small size. Shrews have long, slender snouts which they can move to explore small holes and crevices for food.

WORLD BOOK illustration by John D. Dawson

A shrew is a small animal that resembles a sharp-nosed mouse. The tiniest shrews weigh as little as a U.S. penny.

Their eyes and ears are tiny, and their bodies are covered with short, dark hair. One of the largest shrews in America is the *water shrew,* which is 6 inches (15 centimeters) long. The smallest, the *pygmy shrew,* is about $3\frac{1}{2}$ inches (8.9 centimeters) long.

Shrews eat insects and worms chiefly, but they sometimes kill and eat birds and other small creatures. They even attack mice larger than themselves. They are fierce fighters. The bite of some shrews is poisonous to their prey. Shrews must eat almost continuously during the day in order to satisfy their high energy requirements.

Weasels, foxes, and owls prey upon the shrews. But the shrew's strong musky odor protects it against enemies. The *short-tailed shrew,* which lives in the eastern United States, eats snails. The *masked shrew* is found in the northern United States and in Canada. It usually lives near marshes and streams.

Shrews are harmless to human beings. They are useful in gardens because they eat insects and grubs.

Frank B. Golley

Scientific classification. The shrew belongs to the shrew family, Soricidae. The water shrew is *Sorex palustris.* The short-tailed shrew is *Blarina brevicauda.*

See also **Elephant shrew; Tree shrew.**

Shrike is a bird that can be recognized by its strong, slightly hooked beak. It is sometimes called *butcherbird* because of the way it feeds on its prey. It thrusts grasshoppers, mice, and smaller birds onto thorns, barbs, or twigs, much as a butcher hangs meat. The shrike then tears its prey to pieces and eats it.

There are two species in North America, the *northern shrike* and the *loggerhead shrike.* The northern shrike ranges from the far north in summer to Kansas and Virginia in the winter. The loggerhead shrike nests in Mexico and northward to southern Canada, and travels south for the winter. Both species have gray, black, and white feathers. They use grass and small sticks to build their nests in bushes or low trees. Shrikes are often seen in summer along country roads. The female lays 4 to 8 eggs. They are dull- or grayish-white, and are thickly marked with brown and lavender. The northern shrike is about 10 inches (25 centimeters) long, and the loggerhead shrike is about 9 inches (23 centimeters) long.

The shrike's name may be an imitation of its call notes, which are screeches or shrieks. But its song is a sweet warble. Shrikes are protected by law, because they destroy insects and predatory mammals.

Sandra L. Vehrencamp

Scientific classification. The shrike belongs to the family Laniidae. The northern shrike is *Lanius borealis.* The loggerhead shrike is *L. ludovicianus.*

See also **Bird** (pictures: Birds of brushy areas; How birds feed).

Shrimp are delicate shellfish related to crabs and lobsters. Shrimp are a popular food and make up the most valuable catch of United States fishing crews.

Shrimp are found in fresh and salt water in nearly all parts of the world. Some species live near the shore, where they hide in mud or sand by day and feed by night. Others swim about in groups in deep, cold water. A shrimp generally swims forward. It can swim backward by flipping its fan-shaped tail.

Most shrimp have gray, brown, white, or pink bodies. But some are red, yellow, green, or blue, and some—

Des & Jen Bartlett, Bruce Coleman, Inc.

Runk/Schoenberger from Grant Heilman

Shrimp are shellfish related to crabs and lobsters. An adult shrimp of the genus *Lysmata, left,* has a bright-colored, striped body. The tiny, almost transparent larvae of the brine shrimp, *right,* have a dark eyespot and fewer legs than the adults. They have been magnified 50 times.

such as the peppermint shrimp—have stripes. Some can change color to match their surroundings. Many species are *luminescent* (light-producing).

The smallest shrimp are less than 1 inch (2.5 centimeters) long. Some giant freshwater species grow over 1 foot (30 centimeters) long and have feelers equally long. Larger shrimp are sometimes called *prawns.*

Many small shrimp eat *plankton* (tiny drifting aquatic organisms). Large shrimp feed on material on the sea floor. Shrimp, in turn, serve as an important food for fish and other water animals. Some shrimp help "clean" fish by feeding on parasites from the gills, mouth, and scales of the fish. Other shrimp closely resemble these shrimp, but, instead of eating parasites, they take bites of the gills and flesh of the unsuspecting fish.

The body of a shrimp has two main parts, the *cephalothorax* (head and chest) and the *abdomen.* An unjointed shell covers the cephalothorax. A shrimp can bend because the shell of the abdomen is jointed.

Most shrimp have 19 pairs of jointed legs, feelers, and other *appendages.* The cephalothorax has two pairs of feelers, which taste the water to locate food; a pair of appendages that serve as jaws; five pairs of appendages that handle food; and five pairs of walking legs. The abdomen has five pairs of fanlike *swimmerets,* which are used in swimming and reproduction. It also has a pair of appendages that form part of the shrimp's tail.

Some kinds of shrimp have claws on their two front pairs of walking legs. A shrimp uses its claws to gather food, to fight, and to dig burrows in which to hide. The pistol shrimp makes a sound like a gunshot by snapping one of its claws.

A shrimp's shell is hard and stiff and encloses the animal's body. The only way the shrimp can grow is to *molt* (shed its shell) and grow a new shell. A shrimp molts many times during its life. A new, larger shell hardens after each molt. If any appendages have been lost, new ones develop during the course of several molts.

The life of a shrimp. Various species of shrimp have different life cycles. Some live a year at most, but others may live five years or more. Some females carry their eggs on their swimmerets until they hatch. Others lay their eggs and swim away. Some shrimp do not swim about but live in burrows in sand or mud.

The most common kinds of United States food shrimp, *peneid* shrimp, hatch from eggs laid in the ocean up to 100 miles (160 kilometers) offshore. A newly hatched peneid looks like a tiny pear with legs. It changes shape several times until, after two to four weeks, it looks like a miniature adult.

Young peneid shrimp move toward shore as they develop, but 80 per cent or more may be eaten by sea animals along the way. The survivors settle in bays and river mouths. After about five to seven months of rapid growth, the shrimp begin a two-month trip back to deeper water. They breed in deep water, and each female lays 500,000 to 1,000,000 eggs. Scientists believe that most adult shrimp die soon after the eggs are laid.

Members of another important group of shrimp, the *pandalids,* all begin life as males. At about 2 years of age, they change to females.

The shrimp industry. Fishing crews use pouch-shaped nets called *trawls* to catch shrimp. Boats drag the trawls across the bottom of the sea or river mouth. The catch is frozen or canned quickly because fresh shrimp spoil easily.

About one-third of the world's shrimp catch comes from Asia. China leads the world in shrimp production. Other countries with large shrimp catches include the United States, Thailand, and Indonesia. Louisiana and Texas rank as the leading shrimp-producing U.S. states.

People in Japan sometimes raise shrimp in large tanks and ponds. Such shrimp "farming" has been attempted in the United States, but it has not been profitable.

Scientific classification. Shrimp belong to the class Malacostraca in the subphylum Crustacea. Charles H. Peterson

See also **Fishing industry** (picture: Small U.S. shrimp boats).

Shrine is an object or place sacred to a religion. The term may also refer to a place of national or patriotic importance.

A shrine originally meant a box or chest that contained holy objects. It later came to mean the place where such a container is kept. A shrine is also any structure built on a place considered holy because some significant religious event happened there. In addition, shrines may be built to honor a saint or a virtue. National shrines, such as the Washington and Lincoln monuments or the Tomb of the Unknown Soldier, honor the memory of national heroes. Many people

travel to religious and national shrines to honor whomever or whatever the shrine memorializes. Jill Raitt

See also **Fátima, Our Lady of; Kaaba; Lourdes; Sainte-Anne-de-Beaupré; Unknown Soldier.**

Shrine, The is a fraternal organization. Its full name is Ancient Egyptian Arabic Order of Nobles of the Mystic Shrine. Shriners support 22 hospitals in the United States, Canada, and Mexico. These hospitals provide free specialized medical treatment for crippled and burned children until they reach the age of 18. The Shrine was founded in 1872 by Walter M. Fleming and William J. Florence—two Americans who belonged to a fraternal organization called *Masonry.* The Shrine admits men who have achieved either the 32nd degree in Scottish Rite Masonry or the rank of Knights Templar in York Rite Masonry. It has about 885,000 members. See also **Masonry.** Critically reviewed by the Ancient Egyptian Arabic Order of Nobles of the Mystic Shrine

Shriver, *SHRY vuhr,* **Sargent,** *SAHR juhnt* (1915-), was the Democratic nominee for vice president of the United States in 1972. Senator George S. McGovern of South Dakota and Shriver were defeated by President Richard M. Nixon and Vice President Spiro T. Agnew. In the 1960's, Shriver had served as the first director of the Peace Corps and of the Office of Economic Opportunity (OEO).

Robert Sargent Shriver, Jr., was born in Westminster, Maryland. He graduated from Yale University in 1938 and earned a law degree at Yale in 1941. He was a naval officer in World War II (1939-1945). In 1953, he married Eunice Kennedy, a sister of President John F. Kennedy.

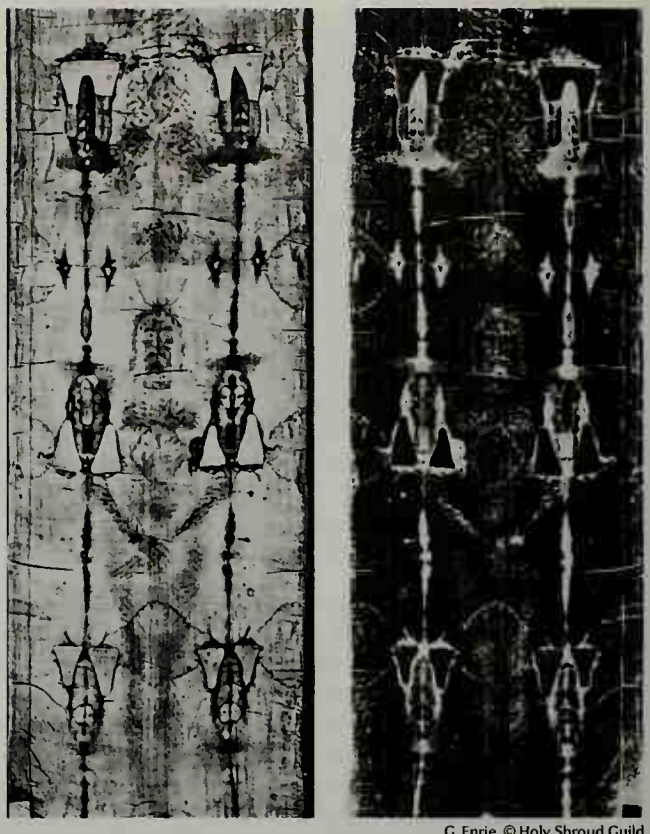
From 1961 to 1966, Shriver directed the Peace Corps under Presidents Kennedy and Lyndon B. Johnson. In 1964, Johnson named Shriver director of the OEO. Johnson appointed him U.S. ambassador to France in 1968, and Shriver held that post until March 1970. In 1972, Shriver replaced Senator Thomas F. Eagleton of Missouri as McGovern's running mate. Eagleton had resigned from the ticket after revealing that he had been hospitalized three times for treatment of emotional exhaustion and depression. David S. Broder

Shroud of Turin, *TOO rihn,* is a linen cloth that many people believe was the burial cloth of Jesus Christ. The cloth measures 14 feet 3 inches by 3 feet 7 inches (434 by 109 centimeters). It bears a faint image of the front and back of a man who was whipped, crowned with thorns, and crucified. Wounds on the image follow the details of the death of Jesus as described in the Bible. The shroud is kept in the cathedral in Turin, Italy.

Some people believe the shroud is the *Mandylion,* a cloth that first appeared in Edessa (now Sanli Urfa, Turkey), in the 500's. The shroud resembles artists' copies of the Mandylion from this period. The Mandylion was taken to Constantinople (now Istanbul, Turkey), in 944. It disappeared in 1204, during the Fourth Crusade.

About 1355, the Shroud of Turin was kept by Geoffrey de Charny, a French nobleman. In 1453, the House of Savoy, a royal family of Italy, acquired the cloth. The Savoys took it to Chambéry, France, where it was damaged in a fire in 1532. They brought it to Turin in 1578.

Many people have challenged the authenticity of the shroud. In 1389, the bishop of Troyes, France, condemned the shroud as a forgery painted about 1355. In 1898, the first photographs of the shroud cast doubt on



G. Enrie, © Holy Shroud Guild

A photograph of the Shroud of Turin shows positive and negative images of a crucified man. For centuries, many people have believed the shroud was the burial cloth of Jesus Christ.

this theory. The negatives of the photographs showed a positive image much clearer and more detailed than the image on the shroud. Thus, it appears that the shroud is a negative image. According to experts, no medieval artist could have painted such an image.

During the 1970's and 1980's, scientists performed many tests on the shroud. In 1978, a team of researchers found that bloodstains on the cloth appeared to be human blood. The team concluded that the image was probably produced by a human body. Other scientists found that pollens and limestone dust from the cloth could have come from the region of Palestine where Jesus died. But the tests proved nothing conclusive. In 1988, scientists used a test called *radiocarbon dating* on cloth from the shroud to determine its age. The tests indicated that the shroud dates only to about 1350. However, some historians and scientists have challenged this conclusion. Daniel C. Scavone

Additional resources

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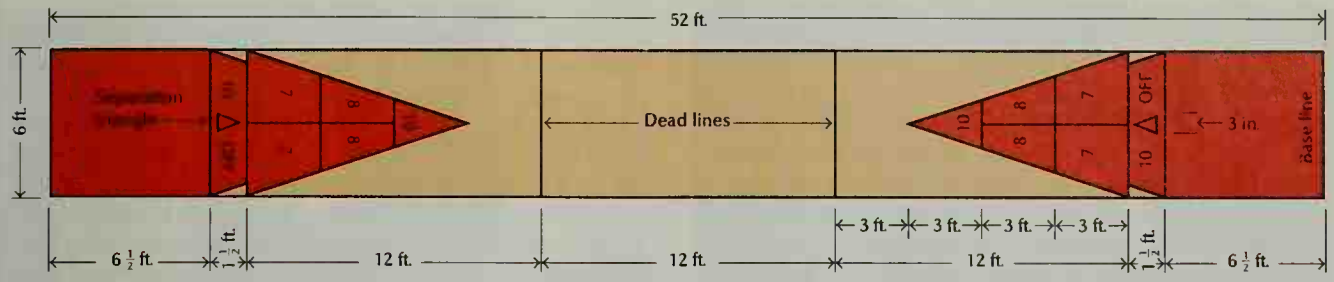
McCrone, Walter C. *Judgement Day for the Turin Shroud.* Microscope Pubns., 1996.

Wilson, Ian. *The Blood and the Shroud.* Free Pr., 1998.

Shrove Tuesday, *shrohv,* is the day before Ash Wednesday, the beginning of Lent. Its name comes from the custom of making confession of sin and receiving forgiveness (being *shriven*) on that day. Shrove Tuesday is a time of celebration in many countries. It corresponds with *Fastnacht* in Germany and *Mardi Gras* in France and the Southern United States. The English celebrate Shrove Tuesday as *Pancake Tuesday* or *Pancake*



Shuffleboard can be played on a smooth, narrow surface, such as a ship's deck.

Day. They traditionally cook and eat flat, thin pancakes on that day. See also **Ash Wednesday; Lent; Mardi Gras.**

David G. Truemper

Shrub is one of the four main groups of plants in terms of size and form. A shrub is a perennial with woody stems that is smaller than a tree. Shrubs usually have several low stems branched near the ground. They also are called *bushes,* especially if they have many branches (see **Bush**). Trees have one large stem, the trunk. Shrubs differ from vines because they stand up without support and do not climb. They differ from herbs because they have hard, woody, long-lived stems. Shrubs grow in almost all parts of the world. They provide cover and food for birds and game, and they protect the soil from erosion. Shrubs are popular for ornamental planting along foundations of houses, in gardens, and as hedges around lawns. Many shrubs produce fragrant blossoms or decorative leaves, twigs, and fruits.

Most shrubs will grow in well-drained soil, spaded to a depth of 1 ½ to 2 feet (46 to 61 centimeters). Smaller plants may be spaced 2 to 3 feet (61 to 91 centimeters) apart, the larger ones 6 feet (1.8 meters) apart. Transplanting may be done in fall or spring. For best growth, prune old branches.

David S. Seigler

For a list of *World Book* articles on shrubs, see the *Related articles* at the end of the **Plant** article.

Shuffleboard is a game played on a flat, slick surface. The players use long-handled sticks called *cues* to try to push plastic disks into a scoring area at the other end of the shuffleboard court. A player also tries to knock his or her opponent's disks out of the scoring area or into a penalty space.

A shuffleboard court is 52 feet (16 meters) long. A disk may measure no more than 6 inches (15 centimeters) in diameter. The cue may be no longer than 75 inches (191 centimeters). Most cues have a head shaped like a half moon. A disk fits into the curved space.

Shuffleboard can be played by two persons or by two teams of two players each. The opposing players stand behind the 10-off space of the court and take turns shooting disks until each person has shot four. A player scores 10 points for each disk in the 10 area, 8 points for the 8 area, and 7 points for the 7 area. He or she loses 10 points as a penalty for each disk in the 10-off space. The winning score may be 50, 75, or 100 points.

Shuffleboard was played in England as early as the 1400's as entertainment for royalty. The game was introduced into the United States in 1913.

Critically reviewed by the National Shuffleboard Association

Shulevitz, Uri (1935-), a book illustrator, won the 1969 Caldecott Medal for his illustrations for *The Fool of the World and the Flying Ship.* This story is based on an old Russian folk tale. Shulevitz was born in Warsaw, Poland. He fled Poland with his family in 1939, soon after the German invasion. After wandering through Europe for eight years, the family settled in Paris in 1947. Shule-

Illustration from *The Fool of the World and the Flying Ship* retold by Arthur Ransome, pictures by Uri Shulevitz. Illustration © 1968 and © renewed 1996 by Uri Shulevitz. Reprinted by permission of Farrar, Straus & Giroux, Inc.

A Shulevitz illustration accompanies Arthur Ransome's retelling of a Russian folk tale called *The Fool of the World and the Flying Ship.* Shulevitz's colorful, detailed illustrations vividly portray the panoramic landscape of old Russia. The artist received the 1969 Caldecott Medal for his illustrations for the book.

vitz lived in Israel from 1949 to 1959, when he moved to New York City. He published his first children's book, *The Moon in My Room,* in 1963.

Shultz, George Pratt (1920-), served as secretary of state in the Administration of President Ronald Reagan from 1982 to 1989. He had previously held several important positions under President Richard M. Nixon. Shultz also served in the United States and abroad as an adviser to governments and to management and labor groups. As an arbitrator in labor disputes, he became noted for his fairness and his ability to bring about settlements.

Before joining the Reagan Administration, Shultz served seven years as president of the Bechtel Group, Inc., a large international engineering company. From 1972 to 1974, he was secretary of the treasury and chairman of the Council on Economic Policy in the Nixon Administration. During that period, he was responsible for coordinating decisions affecting the government's economic policy. Shultz served as Nixon's secretary of labor in 1969 and 1970 and as director of the Office of Management and Budget from 1970 to 1972.

Shultz was born in New York City. He graduated from Princeton University in 1942 and received a Ph.D. degree from the Massachusetts Institute of Technology (MIT) in 1949. Shultz taught economics at MIT from 1948 to 1955, and in 1956 and 1957. He became a professor of industrial relations at the University of Chicago in 1957 and dean of the graduate school of business in 1962.

Lee Thornton

Shumway, Norman Edward (1923-), is an American surgeon who gained fame for his pioneering work in heart transplant operations. Shumway performed the first heart transplant on an adult patient in the United States on Jan. 6, 1968, about a month after Christiaan Barnard of South Africa performed the world's first human heart transplant.

Shumway and his medical team developed and refined methods for heart transplant surgery by doing operations on animals. They found that the major danger in heart transplants was the body's tendency to reject the new heart. Patients often died only days after the operation. During the 1960's and 1970's, Shumway's group improved the surgical techniques and established methods for measuring and treating rejection. About 80 percent of their patients who received heart transplants in the early 1980's survived at least one year. All the patients selected to receive transplants would otherwise have died.

Shumway was born in Kalamazoo, Michigan. He has been on the faculty of Stanford University Medical School since 1958. Toby R. Engel

Shush. See Susa.

Shuttle. See Weaving (Weaving on a loom).

Siam. See Thailand.

Siamese cat. See Cat (Short-haired; picture).

Siamese twins. See Conjoined twins.

Sian. See Xi'an.

Sibelius, *sih BAY lee uhs,* **Jean,** *zhahn* (1865-1957), was a Finnish composer. His most important works are his seven symphonies and many symphonic poems for orchestra. Sibelius based most of his symphonic poems on Finland's national epic poem, the *Kalevala.* These compositions express Sibelius's impressions of Finland's forests, lakes, cool summers, and snowy winters.

Sibelius's earlier and more melodious compositions became his most popular works. They include *The Swan of Tuonela* (1893), *Finlandia* (1900), *Second Symphony* (1902), and *Valse Triste* (1904). He developed a less melodious style after about 1904. His *Fifth Symphony* (1915) is the best introduction to his later style. In both his earlier and later symphonies, Sibelius first stated his themes in fragmentary form. He developed the themes during the composition and presented them in complete form near the end of each movement or work.

Sibelius was born in Hämeenlinna. He studied music at the Helsinki Conservatory and then, from 1889 to 1892, in Berlin and Vienna. The government awarded Sibelius a pension in 1897, enabling him to devote himself to composing.

Sibelius's most famous work, *Finlandia,* was first performed in 1900 in Helsinki. At that time, Russia ruled Finland. *Finlandia* expressed so much national pride and patriotism that for many years the Russians refused to permit its performance. But the work became the anthem of the Finnish independence movement. Russian troops left Finland in 1918.

During the early 1900's, Sibelius became internationally known as a composer and conductor. But he stopped composing in 1929 because he disliked the new trends in composition and did not wish to write in the modern styles. R. M. Longyear

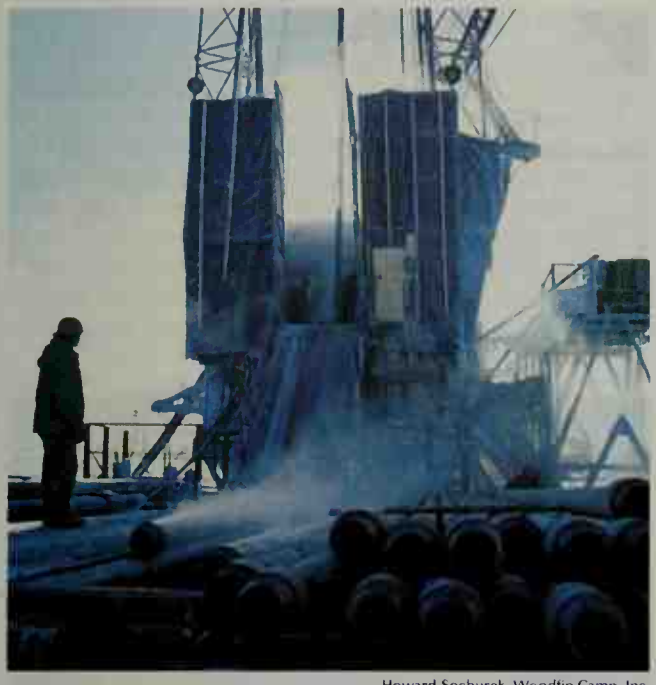
Siberia, *sy BIHR ee uh,* is a vast, thinly populated region in northern Asia. It lies within Russia. Siberia makes up about 75 percent of the area of Russia, but only about 20 percent of the Russian people live there. Ice and snow cover most of the region about six months a year, and the temperature sometimes drops below −90 °F (−68 °C).

Through the centuries, Russian, and later Soviet, rulers sent millions of criminal and political prisoners to isolated parts of Siberia. The Soviet Union was formed under Russia's leadership in 1922, and it existed until 1991. Many prisoners were forced to work as laborers building factories, mines, and railroads. In the 1930's, the Soviet Union began to mine Siberian coal and minerals. Oil and natural gas production on a large scale began in the 1960's and 1970's.

The land and climate

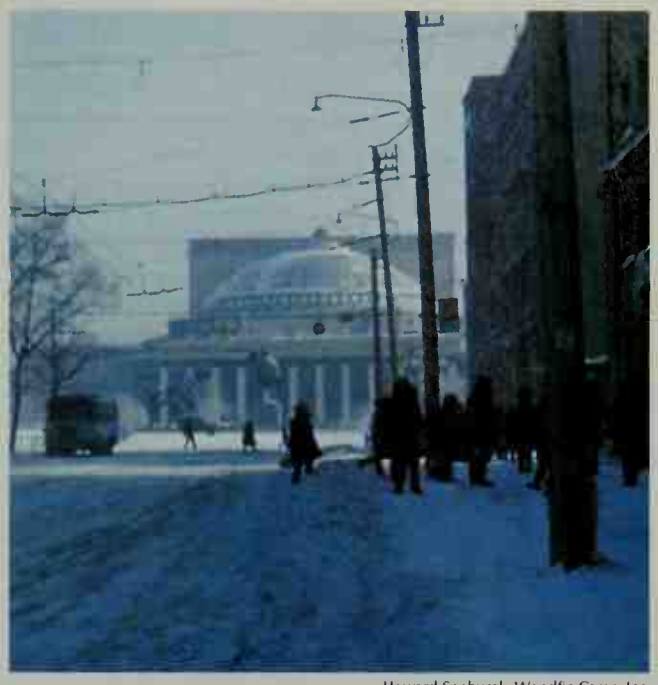
Siberia covers about 4,929,000 square miles (12,766,000 square kilometers). It has three main areas—the West Siberian Plain, the Central Siberian Plateau, and the East Siberian Highlands. The West Siberian Plain, the largest level region in the world, extends from the east side of the Ural Mountains to the Yenisey River. The Central Siberian Plateau lies between the Yenisey and Lena rivers. Lake Baikal, the world's deepest lake, lies on the plateau's southern edge. It is 5,315 feet (1,620 meters) deep. The East Siberian Uplands consist of a series of mountain ranges between the Lena River and the Pacific coast. This area includes Siberia's highest point, an active volcano named Klyuchevskaya that rises 15,584 feet (4,750 meters).

Moss, lichens, and a few kinds of small shrubs grow in the *tundra,* a narrow belt of vegetation along Siberia's Arctic coast. South of the tundra, a vast evergreen forest called the *taiga* spreads from the Urals to the Pacific



Howard Sochurek, Woodfin Camp, Inc.

Drillers sink an oil well into the frozen ground at Samotlor, a Siberian oil field near the Ob River, about 450 miles (720 kilometers) northwest of Novosibirsk. Wells along the Ob River produce most of Russia's oil.



Howard Sochurek, Woodfin Camp, Inc.

Novosibirsk is Siberia's biggest city and one of the largest in Russia. The city was founded in 1893 and expanded rapidly after the government established many factories there during World War II (1939-1945).

coast. In the extreme southwest lie the *steppes* (grasslands), Siberia's richest farming area.

Arctic foxes, lemmings, and reindeer live in the tundra; and ermines, lynxes, red foxes, and sables make their home in the taiga. Fishing crews catch cod, crabs, and salmon off the Pacific coast.

Average temperatures in northeastern Siberia range from −59 °F (−51 °C) in January to 59 °F (15 °C) in July. In the steppes, they vary from 3 °F (−16 °C) in January to 64 °F (18 °C) in July. The annual *precipitation* (rain, melted snow, and other moisture) averages 5 inches (13 centimeters) in the north and 31 inches (80 centimeters) in the steppes. A layer of permanently frozen ground called *permafrost* covers most of eastern Siberia.

The people

Siberia has a population of about 31 million, but the region has a population density of only 6 persons per square mile (2 persons per square kilometer). Siberia makes up the Asian part of Russia. The European part of Russia is about 12 times as densely populated as Siberia. Siberia's population has grown slowly. During some years, because of the harsh living conditions, more people leave than move there.

The use of forced labor for Siberian construction projects ended after the Soviet dictator Joseph Stalin died in 1953. The government then began trying to attract workers to Siberia by offering such rewards as high salaries and long vacations. But many workers stay only a few years before leaving for better living conditions elsewhere.

Most Siberians are Russians. The government has moved many settlers into the region since the 1700's. Such Mongol and Turkic groups as Buryats, Tuvinians, and Yakuts lived there originally, and still do.

About 70 per cent of Siberia's people live in cities. Most city people are crowded into small apartments. Many people in rural areas live in simple, but more spacious, log houses. Novosibirsk, the largest city in Siberia, has a population of about 1 $\frac{1}{2}$ million. Other Siberian cities with over 500,000 people include Omsk, Krasnoyarsk, Vladivostok, Irkutsk, Barnaul, Khabarovsk, Novokuznetsk, and Kemerovo.

WORLD BOOK map

Location of Siberia

Economy

Siberia has an abundance of natural resources. Many minerals, including diamonds, gold, platinum, tin, and tungsten, are mined in harsh, isolated areas. Vast oil fields along the Ob River began operating in 1965. The fields now produce most of Russia's oil. Much of the country's coal is mined in Siberia, chiefly from deposits in the Kuznetsk Basin in Western Siberia. Western Siberia accounts for most of Russia's gas production. Siberian forests supply timber.

Most of the hydroelectric power generated in Russia comes from dams on Siberia's rivers, especially on the Angara and Yenisey rivers. Sayano-Shushensk Dam on the Yenisey River, one of the world's largest power dams, generates about 6 $\frac{1}{2}$ million kilowatts.

Siberian manufacturing is centered mainly in the Kuznetsk Basin. Leading products include building materials, chemicals, and farm machinery. The southern steppes include the region's most productive farmlands. Farmers there grow barley, oats, and wheat. Livestock raised in Siberia include cattle, sheep, and reindeer, and the region has many dairy farms.

The Trans-Siberian Railroad, which crosses southern Siberia, carries passengers and freight to and from the European part of Russia. Almost all of Siberia's resources are used in the European part, where most of the people live. The railroad transports coal and other minerals, and pipelines carry oil and natural gas. In the icebound Arctic Ocean, shipping lanes remain open for only a few months in summer. Airlines connect Siberian cities with cities in the European part of the country.

A network of radio stations and a television communications satellite serve all Siberia. Telegraph lines connect the major areas of the region.

History

People were living in Siberia by about 30,000 years ago. Asian nomads called Tatars, under the Mongolian emperor Genghis Khan, conquered the southern steppes during the early 1200's. They drove many of the original tribes into the northern forests. In the late 1500's, a band of Russian Cossacks, led by an adventurer named Yermak, defeated the Tatars. Russian fur traders reached the Pacific coast about 1630. By 1700, the Russians controlled almost all Siberia.

In the early 1900's, the national government began to build industries in Siberia. It moved hundreds of factories and thousands of workers from the European part of the Soviet Union to Siberia during World War II (1939-1945). This action protected the factories from the German armies that invaded the Soviet Union from the west.

In the mid-1900's, scientists discovered large deposits of coal, oil, and other resources in Siberia. In 1974, construction began on a 1,900-mile (3,100-kilometer) railroad called the Baikal-Amur Mainline, which was to run between Lake Baikal and Komsomolsk, about 200 miles (320 kilometers) north of Khabarovsk. The railroad opened in 1984 and was operating along its entire length by the early 1990's. Craig ZumBrunnen

Related articles in *World Book* include:

Cities

Irkutsk, Novosibirsk, Omsk, Vladivostok

Physical features

Amur River, Kamchatka Peninsula, Lake Baikal, Lena River, Ob River, Sakhalin, Yablonovyy Mountains, Yenisey River

Other related articles

Arctic, Exploration (The Russians in Siberia), Inuit, Permafrost, Russia, Trans-Siberian Railroad

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Mote, Victor L. *Siberia.* Westview, 1998.

Tayler, Jeffrey. *Siberian Dawn: A Journey Across the New Russia.* Ruminator, 1999.

Siberian husky, *sy BIHR ee uhn,* is an Arctic sled dog. It is related to the Alaskan malamute, the American Eskimo dog, and the Samoyed. It originated in Siberia. A graceful, quick dog, the husky is also alert and strong. It has a thick, soft, double coat, with a smooth outer coat and a downy undercoat. It is usually gray, tan, or black, often with white markings. The husky stands about 20 to 23 inches (51 to 58 centimeters) high and weighs 35 to 60 pounds (16 to 27 kilograms)

American Kennel Club Library

The Siberian husky is an alert, powerful dog.

Critically reviewed by the American Kennel Club

See also Dog (picture: Careful grooming); Sled dog.

Sibyl, *SIHB uhl,* was the name ancient Romans gave to any aged woman who could supposedly tell the future. The best known was the Cumaean Sibyl. According to mythology, the god Apollo promised she would live one year for each grain of sand she could hold in her hands. However, Apollo did not give her eternal youth, and she continued to age. Sibyl guided Aeneas, the Trojan warrior, to the lower world to learn the future of Rome. Later, she offered to sell nine books of prophecy, called the Sibylline Books, for a high price to a king of Rome. When he refused, Sibyl burned six of the books. He finally paid the original price for only three. The Romans consulted these books in times of danger. The books were destroyed by fire in 83 B.C.

Arthur M. Eckstein

Sicilies, *SIHS uh leez,* **Kingdom of the Two,** was the name of an early kingdom of Italy. It consisted of the Kingdom of Naples in southern Italy, and the Kingdom of Sicily on the island of Sicily. At times, they were united as the *Two Sicilies* (see **Italy** (maps)). The kingdom was formed in the early 1100's by Normans, who conquered the region during the 1000's. See **Middle Ages** (map: Europe about 1000).

In 1266, the Two Sicilies came under French rule. In 1282, an uprising known as the Sicilian Vespers took place in Sicily. It resulted in the massacre of nearly all the French on the island. Sicily was later separated from

Naples and ruled by the Spanish. In the War of the Spanish Succession in 1713, Austria seized Naples, and Sicily was given to Savoy. Savoy turned Sicily over to Austria in 1719, in exchange for Sardinia.

In 1734, Spain conquered Naples and Sicily, and a member of the royal Spanish Bourbon family became their ruler. Under Napoleon, the French held Naples briefly in 1799 and again from 1806 to 1815. Later in 1815, it was returned to Bourbon rule. In 1816, Naples and Sicily were formally united as the Kingdom of the Two Sicilies.

The Kingdom of the Two Sicilies played an important part in the movement for a united Italy. In 1820, there was an uprising in Naples of the Carbonari, a secret nationalist society. King Ferdinand was forced to grant the Neapolitans a constitution. An Austrian army invaded Naples and restored Ferdinand to power.

In 1860, the Italian military leader Giuseppe Garibaldi conquered the Kingdom of the Two Sicilies for the Kingdom of Italy, which was just coming into being. Later that year, the Kingdom of the Two Sicilies became part of the domain of Victor Emmanuel II, who became king of Italy in 1861. R. Burr Litchfield

Sicily, *SIHS uh lee* (pop. 4,966,386), is an Italian island in the central Mediterranean Sea. The Strait of Messina separates Sicily from the mainland of Italy. For Sicily's location, see **Italy** (political map). Sicily covers 9,926 square miles (25,708 square kilometers) and is the largest island in the Mediterranean.

Sicily is one of Italy's 20 governmental units called *regions.* Palermo, a center of industry and trade, is the capital, largest city, and chief seaport of Sicily. Messina, on the northeastern coast, serves as a gateway to the island. Workers commute daily by ferry across the strait between Messina and the Italian mainland.

The people. Sicily's location made it a crossroads for many civilizations. A number of peoples invaded and settled on the island, including Greeks, Carthaginians, Romans, Muslims from North Africa, and Normans. Today, Sicily has a mixture of these civilizations. For example, the people speak local *dialects* (forms of speech) that have traces of Arabic, Greek, and other languages.

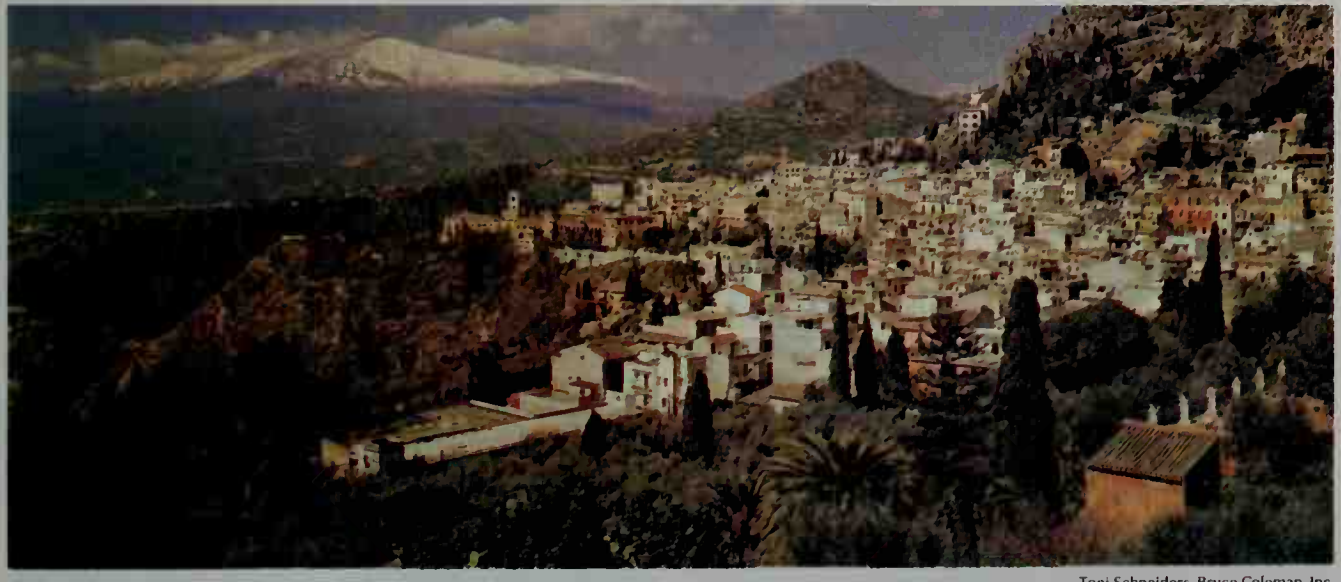
The people of Sicily have strong bonds of family and friendship. The hundreds of years of invasion and foreign rule discouraged the people's trust in government and encouraged a code of *omertà.* According to the code, a person who cooperates with the government is dishonorable. This code and the island's tradition of private justice provide support for the Mafia. The Mafia is a network of groups engaging in various illegal activities. Protection for Mafia activities also has come from politicians who owe their positions to Mafia support. However, many Sicilian people have begun to oppose Mafia activities. During the 1980's and 1990's, the Italian government waged a campaign against organized crime and convicted hundreds of people associated with the Mafia. See **Mafia.**

Many Sicilians are farmers. Others work in the fishing industry and other industries. A lack of jobs was a chief reason for a high rate of emigration in the late 1800's and early 1900's. From 1876 to 1925, more than a million Sicilians moved to the United States. Since 1945, many Sicilian workers have settled in the industrial cities of northern Italy, France, Germany, and Switzerland.

Most Sicilians are Roman Catholics. Their religious celebrations often include colorful processions, horse races, pole-climbing contests, and fireworks displays.

Many famous landmarks attract tourists to Sicily. Greek ruins stand at Agrigento, Syracuse, Taormina, and other places in Sicily. Many Sicilian cathedrals and palaces exhibit works of art. Educational institutions include universities in Catania, Messina, and Palermo.

Land and climate. Mountains and hills cover more than 85 percent of Sicily. The island's highest point is Mount Etna, an active volcano that rises to 10,902 feet (3,323 meters) on the east coast (see **Mount Etna**). Mount Etna erupts periodically. Catania had to be rebuilt entirely after an eruption destroyed it in 1669. But the area around Mount Etna is heavily populated because volcanic ash makes the soil fertile. Earthquakes have also hit Sicily. Messina had to be rebuilt after an earthquake wrecked it in 1908.



Toni Schneiders, Bruce Coleman, Inc.

The town of Taormina, Sicily, lies among the hills near Mount Etna, a snow-capped volcano, *background.* Hills and mountains cover most of Sicily, and Mount Etna is its highest peak.

Sicily has a mild climate. Temperatures average 45 °F (7 °C) in winter and 79 °F (26 °C) in summer. The island gets most of its rain during the winter. Little rain falls from March to October, and the air becomes even drier because of a hot, dry wind called the *sirocco*. This wind blows across the Mediterranean Sea from the deserts of North Africa. Sicilian rivers dry up in summer, and the land becomes parched in unirrigated areas.

Sicily was once heavily wooded, but most of the trees have been cut, leaving the mountainsides bare and easily eroded. Farmers use much of the island for growing wheat and for grazing goats and sheep. Along the coasts, irrigation provides water for such crops as almonds, grapes, lemons, olives, oranges, and potatoes.

Economy. Sicily has often prospered in its long history. But since the 1400's, its economy has become underdeveloped. Most of the land was divided into large estates owned by a few people. Farmers used outdated methods and did little to stop soil erosion. Sicily had few industries to provide jobs. In the 1800's, Sicilian mines supplied four-fifths of the world's sulfur. But by 1900, foreign competition had weakened the industry.

Since the 1950's, Sicily's economy has started to improve. A government land reform program broke up some of the large estates, and small farmers received plots of their own. The government planted trees to prevent erosion, expanded irrigation projects, and built dams to collect winter rainfall for use in the summer.

Some industries developed as the result of the discovery of oil at Ragusa in 1954 and later at Gela. A pipeline opened in 1957 and linked the Ragusa oil field to a large new refinery in the port city of Augusta. The refinery also uses large quantities of oil imported from the Middle East. Factories in several coastal cities refine sulfur and make fertilizer from potash. Sicily produces much of Italy's asphalt and salt. Sardine and tuna fishing and tourism also are important industries.

Government. In 1948, Sicily became a semi-independent political region of Italy. The island has nine provinces and a 90-member parliament. It also sends representatives to the federal government in Rome.

History. Discoveries of cave drawings and tools show that prehistoric people lived in what is now Sicily. During the 700's B.C., the Greeks colonized the eastern part of the island, and the Carthaginians founded trade settlements in the western part. The Romans conquered Sicily in the 200's B.C. and made it their first province. Sicily grew grain for the Roman Empire.

After Rome declined during the A.D. 400's, the Vandals and the Ostrogoths conquered Sicily. In 535, the island came under the control of the Byzantine Empire. Greek became the official language of the island's people. North African Muslims replaced the Byzantine rulers in the 800's. Sicily flourished during about 200 years of Muslim rule. The Muslims introduced irrigation and such crops as cotton, lemons, and oranges. Muslim art, literature, and science influenced the Sicilians.

During the 1000's, the Normans conquered Sicily. They joined Sicily with southern Italy and formed the Kingdom of the Two Sicilies. Under the Normans, the island's culture gradually became Western European. In the 1200's, German—and, later, French—rule added to the mixture of traditions in Sicily. During this period, Sicily became the cultural center of Italy. In 1282, an uprising called the *Sicilian Vespers* ended French rule.

During the next 400 years, Sicily was ruled by Spain, Savoy, and Austria. In the 1700's, a Spanish branch of the royal Bourbon family began to rule Sicily. In 1816, Sicily and Naples were joined as the Bourbon-ruled Kingdom of the Two Sicilies. After the Italian patriot Giuseppe Garibaldi invaded Sicily in 1860, the island revolted against Bourbon rule. Sicily became part of the Kingdom of Italy in 1861. During World War II, the Allies bombed Sicily's air and naval bases. Allied troops landed on Sicily on July 10, 1943. The Allies occupied all of Sicily after Messina fell on August 17. The island then became the springboard for the Allied invasion of Italy.

Since the 1950's, the government has funded modern highways and other improvements. Tourism in Sicily has increased, but industry remains weak. John A. Davis

Related articles in *World Book* include:
Garibaldi, Giuseppe
Italy
Messina
Palermo
Sicilies, Kingdom of the Two
Syracuse

Sickle cell anemia, *uh NEE mee uh,* also called sickle cell disease, is a hereditary blood disease. In the United States, it occurs chiefly among African Americans. It also affects other groups, including people of Central African, Mediterranean, Middle Eastern, and Indian origin. The disease causes periodic *crises* (attacks of severe pain and fever), moderate to severe anemia, and problems related to disruption of blood flow, including strokes, lung or kidney damage, and sudden death.

Sickle cell patients have an abnormal type of *hemoglobin,* the oxygen-carrying protein that gives red blood cells their color. The abnormal protein, called *sickle hemoglobin,* or *hemoglobin S,* forms crystals in red blood cells when the cells release oxygen as they flow through tissues in the body. The crystallized hemoglobin causes the normally round red blood cells to change into twisted, rigid sickle forms. The sickled cells can get trapped and block the normal flow of blood through tiny blood vessels called *capillaries.* This disruption of blood flow causes the periodic crises.

Sickle cell anemia occurs when a child inherits the gene for sickle hemoglobin from both parents. About 1 of every 10 African Americans has one copy of the gene. These people have *sickle cell trait* but do not have the disease. About 1 of every 600 African Americans is born with two copies of the gene and has the disease.

Early diagnosis of sickle cell anemia, usually at birth, and antibiotics to prevent infections have greatly improved the survival and life span of persons with sickle cell anemia. Doctors may treat sickle cell anemia with *hydroxyurea,* a drug that can reduce the frequency of painful attacks and the need for blood transfusions.

Some young children with sickle cell anemia can be cured by a *bone marrow transplant.* Such a transplant involves destroying the patient's blood-forming tissues with drugs and replacing the tissues using bone marrow *stem cells* from a healthy donor. The stem cells develop into bone marrow that produces red blood cells with normal hemoglobin. However, suitable donors are not always available, and this treatment carries some risk of serious illness or death. James R. Eckman

See also **Bone marrow transplant; Genetic testing; Races, Human** (Susceptibility to genetic diseases).

Sickness. See **Disease.**

Siddons, *SIHD uhnz,* **Sarah Kemble** (1755-1831), was one of England's greatest tragic actresses. She enchanted audiences and critics with her rich voice, striking beauty, and powerful presence. She became a subject of poets and painters.

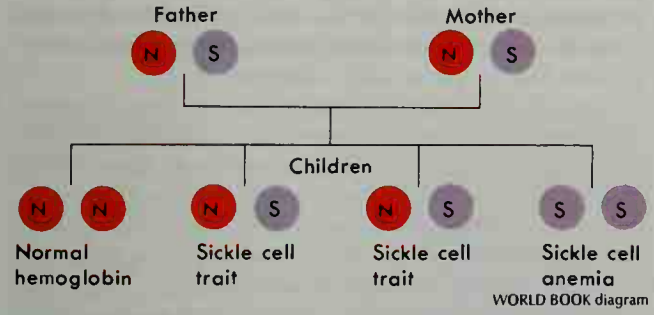
Portrait by Thomas Gainsborough, The National Gallery, London

Sarah Siddons

Siddons was born in Wales, where her father, Roger Kemble, was touring with his English acting company. She married actor William Siddons when she was 18. In the 1775-1776 season, Siddons failed as an actress in David Garrick's Drury Lane Theatre in London. She gained more experience acting in the English provinces, rejoined Garrick's company in 1782, and became a success. Her brothers Charles Kemble, John Philip Kemble, and Stephen Kemble also became noted actors. Don B. Wilmeth

Sickle cell anemia

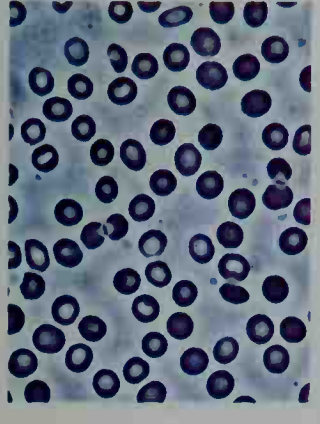
Sickle cell anemia is a hereditary blood disease that can damage body organs. People with sickle cell anemia have inherited the gene for sickle hemoglobin from both of their parents.

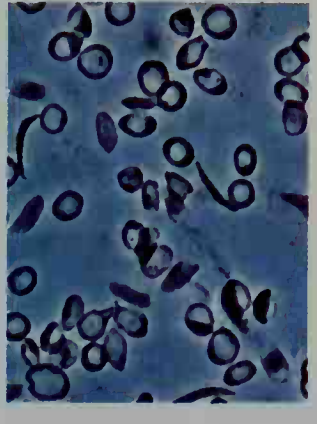


WORLD BOOK diagram

In the chart above, each parent carries one gene for normal and one gene for sickle hemoglobin. A child of such parents has one chance in four of inheriting the gene for sickle hemoglobin from both parents, and thus developing sickle cell anemia. People who inherit the sickle gene from only one parent do not get sickle cell anemia. But they have a condition called *sickle cell trait* and can pass the sickle gene on to their children. The magnified blood samples below show normal red blood cells, *left,* and abnormal blood cells of a person with sickle cell anemia, *right.* Typical blood cells in patients with sickle cell anemia are long, pointed, and deep red. The other cells have sickle hemoglobin but have not yet changed into twisted sickle forms. The cells in people with sickle cell trait are normal in appearance.

Eric V. Gravé





Sidereal time, *sy DIHR ee uhl,* measures the rotation of the earth in relation to the stars. By contrast, *mean solar time* (average solar time), which we use to tell time in our daily lives, measures the earth's rotation in relation to the sun. Astronomers use sidereal time because the stars are in the same place in the sky at the same sidereal time each night. The stars are not in the same place at the same mean solar time each night.

A sidereal day consists of 24 sidereal hours. It is the time the earth takes to make one rotation on its axis with respect to an imaginary line that extends from earth's center to a point in the sky called the *vernal equinox* (see **Equinox**). To measure a solar day, astronomers determine the time required for the earth to make one rotation with respect to an imaginary line from the earth's center to the sun (see **Time** [Measuring time]).

A mean solar day is longer than a sidereal day. To understand why this is so, consider a point on the earth's surface that is on the imaginary line to the vernal equinox and the imaginary line to the sun. During the time this point takes to make one rotation with respect to the line to the vernal equinox (one sidereal day), the earth moves about one degree along its orbit. As a result, the point has not yet reached the line to the sun. The point needs nearly 4 additional minutes to rotate to this line. A mean solar day equals 24 hours 3 minutes 56.555 seconds of sidereal time. Donald K. Yeomans

Sidney, Sir Philip (1554-1586), was an English author, courtier, and soldier. He became famous for his literary criticism, prose fiction, and poetry.

In *The Defence of Poesie* (1580?), Sidney championed "right" poetry—that is, fiction—against a variety of its enemies. This was the first major literary criticism in English. Sidney opposed the proposed marriage of Queen Elizabeth I and the Duke of Anjou in 1580. He went into temporary retirement at the home of his sister Mary, Countess of Pembroke. For her amusement, he wrote a romantic prose and verse narrative *Arcadia* (1580). He later made major revisions, but the countess edited the work into its final form.

Sidney's greatest work is *Astrophel and Stella,* which consists of 108 sonnets and 11 songs. This sequence—written in the 1580's—is one of the great works produced during the Elizabethan fashion for sonnet cycles.

Sidney was born in Penshurst in Kent. He traveled widely and was popular at court. In 1585, Sidney became governor of Flushing in the Netherlands. He died of a wound in battle there the next year. John N. King

Sidon, *SYD uhn,* was an important manufacturing and port city in ancient Phoenicia. The present-day town of Sayda, Lebanon, occupies its site.

Sidon was most famous for its purple dye and blown-glass industries. The Greek poet Homer mentioned silver bowls of Sidon. Sidon was usually overshadowed in importance by the nearby Phoenician city of Tyre (now Sur, Lebanon), which was its chief commercial rival. But Sidon enjoyed a brief period of supremacy and independent prosperity after Babylonia defeated Tyre in 573 B.C. Louis L. Orlin

SIDS. See Sudden infant death syndrome.

Siegbahn, *SEEG bahn,* **Karl Manne Georg,** *MAHN nuh YAY awr yuh* (1886-1978), a Swedish physicist, received the 1924 Nobel Prize in physics for his work with X rays and a method of analysis called *X-ray spectros-*

copy. He turned from an interest in electricity and magnetism to the study of X rays in 1914. He developed new types of X-ray spectrographs and improved X-ray tubes. With this more accurate equipment, he was able to make more precise measurements than had previously been possible. He also investigated the internal structure of atoms through the study of their X-ray spectra.

Siegbahn was born in Örebro, Sweden, and received his doctor's degree in 1911 from the University of Lund, in Sweden. In 1937, he became director of the Nobel Institute for Physics at the Stockholm Academy of Sciences. Siegbahn's son Kai won the 1981 Nobel Prize in physics for his contribution to the development of high-resolution electron spectroscopy. Gregory Benford

Siegfried, *SEEG freed,* was a legendary hero in medieval German literature. As a young man, Siegfried had acquired the fabulous treasure of the Nibelungs and a cloak that made him invisible. He also killed a dragon and bathed in its blood, which made his body invulnerable. But a linden leaf had fallen on the spot between his shoulders, leaving the spot unprotected. Years later, Hagen, a member of the Burgundian court, killed Siegfried by thrusting a spear into the unprotected spot. Hagen later took the treasure from Siegfried's wife.

Siegfried is the hero of the *Nibelungenlied,* an epic poem composed by an unknown author about A.D. 1200. Siegfried is known as Sigurd the Volsung in the *Volsunga Saga,* a prose story written in Iceland in the 1100's or 1200's. The German composer Richard Wagner drew upon both works in his cycle of four operas, *The Ring of the Nibelung* (1869-1876). C. Scott Littleton

See also **Brunhild; Nibelungenlied; Sigurd.**

Siegfried Line, *SEEG freed,* was the name of two fortified lines of defense established by Germany in the 1900's. German generals Paul von Hindenburg and Erich Ludendorff had the first Siegfried Line built in the winter of 1916-1917, during World War I (1914-1918). The line stretched across northern France and Belgium. The Allies, who called the barrier the *Hindenburg Line,* smashed it near the end of the war.

During the 1930's, Nazi dictator Adolf Hitler built a new Siegfried Line along the border between Germany and France. This chain of forts and tank defenses stood opposite the Maginot Line, a massive line of fortifications built by France (see **Maginot Line**). The Allies broke through Hitler's Siegfried Line during World War II (1939-1945). Parts of this line still stand. Theodore Ropp

See also **World War I** (The final stage; map).

Siemens, *SEE muhnz* or *ZEE muhns,* **Sir Charles William** (1823-1883), was a German-born engineer, inventor, and industrialist. He made important contributions to the steel and telegraph industries.

Siemens was born Karl Wilhelm Siemens in Lenthe, Germany, near Hanover. In 1844, he moved to Britain, where he was known as William Siemens. Along with two brothers, he founded a company that became a leader in manufacturing and laying underwater telegraph cables. In 1856, William and his brother Friedrich invented the regenerative gas furnace. This furnace pioneered the open-hearth process of steelmaking and led to great increases in steel production (see **Iron and Steel** [The birth of modern steelmaking]). He was knighted Sir Charles William Siemens by Queen Victoria in 1883. James E. Brittain

Siemens, *SEE muhnz* or *ZEE muhns,* **Ernst Werner von** (1816-1892), was a German inventor and industrialist who contributed to telegraphy and electric power generation. He also was a founder of Siemens, now one of the world's largest manufacturers of equipment.

Siemens was born in Lenthe, Germany, near Hanover. As a young man, he invented an electrical method of gold and silver plating, and an improved telegraph transmitter. In 1847, Siemens and Johann Halske, a maker of scientific instruments, founded a company. The firm set up telegraph lines in Germany, Russia, and other nations. In 1866, Siemens discovered the principle of the electric dynamo, which made it possible to generate electricity by means of electromagnets instead of permanent magnets. The Siemens company soon developed into a manufacturing giant. James E. Brittain

Sienkiewicz, *shehn KYEH veech,* **Henryk,** *HEHN rihk* (1846-1916), was a popular Polish novelist. He won the Nobel Prize for literature in 1905. His most celebrated novel is *Quo Vadis?* (1896), a story of Roman society under Nero. *With Fire and Sword* (1884) was the first of three related novels that describe society in Poland during the wars of the 1600's against the Cossacks, Turks, and Swedes.

Sienkiewicz was born in Wola Okrzejska, near Łuków. He became a leader of patriots working for Polish independence. John J. Kulczycki

Sierra Club, *see AIR uh,* is an organization in the United States and Canada that works to protect the environment. It also provides opportunities for its members to explore forests, parks, and wilderness areas.

The club has about 540,000 members. Local chapters organize conferences, lectures, films, exhibits, mountain-climbing and skiing expeditions, and other trips. The club has hundreds of committees that strive to save threatened natural resources, scenic areas, and wildlife. The club publishes a biweekly news report, a bimonthly magazine, books, and special publications.

The club was founded in 1892 in San Francisco by the naturalist John Muir. Muir, who wanted to preserve the beauty of the Sierra Nevada mountain range in California, became the group's first president (see **Muir, John**). The club's headquarters are in San Francisco.

Critically reviewed by the Sierra Club

Sierra Leone, *see AIR uh lee OHN,* is a small country on Africa's western "bulge," north of the equator. Sierra Leone provides a large portion of one of the world's most valuable treasures—diamonds. It is among the leading countries in the production of diamonds used for gems and also of diamonds used in industry. The diamonds lie in gravel deposits along riverbeds and in swamps in eastern parts of the country. About 70 percent of the diamonds are used to make gemstones, and the rest are less expensive diamonds used in industry.

Sierra Leone, a former British colonial possession, became independent in 1961. It remained a member of the Commonwealth of Nations. Freetown is the country's capital, largest town, and main port. The city was founded in 1787 as a settlement for freed slaves.

Government. According to Sierra Leone's Constitution, the president is the head of state. The president is elected by the people to a five-year term. A cabinet, appointed by the president with the approval of parliament, carries out the daily operations of government.

Facts in brief

Capital: Freetown.
Official language: English.
Area: 27,699 mi² (71,740 km²). *Greatest distances*—north-south, 220 mi (354 km); east-west, 190 mi (306 km). *Coastline*—210 mi (338 km).
Population: *Estimated 2002 population*—5,067,000; density, 183 per mi² (71 per km²), distribution, 63 percent rural, 37 percent urban. *1985 census*—3,515,812.
Chief products: *Agriculture*—cacao, cassava, coffee, ginger, oranges, palm kernels, peanuts, piassava, rice. *Mining*—chrome ore, diamonds, iron ore, rutile.
Flag: Three horizontal stripes—green, white, and blue. See Flag (picture: Flags of Africa).
Money: *Basic unit*—leone. One hundred cents equal one leone.

Parliament also has lawmaking power. Parliament's 80 members serve five-year terms.

People. Most of the men of Sierra Leone are farmers. But many grow only enough food for their families and work during the dry season mining diamonds. Many of the women sell goods in local markets. Freetown has many modern buildings. Many people in villages live in concrete block houses, and many of the poor people in rural areas live in mud houses with corrugated iron or thatched roofs.

Most of Sierra Leone's people are black Africans who form 12 main ethnic groups. About a third of the people belong to the Mende group. They live in the southern part of the country. About a third of the people belong to the Temne ethnic group, who live in western Sierra

© Michelle Burgess, The Stock Market

Freetown is Sierra Leone's capital and trade center. The city was founded in 1787 as a home for freed slaves.

Leone. Less than 2 percent of the people are Creoles, who live in or near Freetown. They are descended from freed slaves. English is Sierra Leone's official language. However, most of the people speak local African languages. The Creoles speak Krio, a local form of English.

Most of the people practice local religions. For example, the Mende believe Ngewo (God) created the world and everything in it. They place great value in *nomoli,* small humanlike figures carved in stone, which they find in the soil. They believe that possessing one will bring them an abundant yield of crops. No one knows for certain who carved the nomoli, but scholars believe they date from the 1400's. Some people, such as the Creoles, are Christians. Others are Muslims.

The law does not require the children of Sierra Leone to go to school. But about 40 percent attend elementary school, and approximately 15 percent go to high school. The University of Sierra Leone is in Freetown.

Land. Freetown is at the end of the Sierra Leone Peninsula. The Sierra Leone mountains rise to about 3,000 feet (910 meters) above sea level there. Swamps cover most of the country's coastal region and extend about 20 miles (32 kilometers) inland.

Inland from the swamps, a coastal plain extends as far as 100 miles (160 kilometers) in the northern part of the country. This plain slopes up to a region of plateaus and mountains in the northeast that covers about half of the country. The mountains rise to more than 6,000 feet (1,800 meters) near the eastern border with Guinea. Loma Mansa, 6,390 feet (1,948 meters), is the country's highest point. Gravel or sandy soil, on which only short grass grows, covers more than half the country.

Sierra Leone has a rainy, tropical climate. The dry season lasts through January and February in the south, and from December through March in the north. Freetown receives about 144 inches (366 centimeters) of rainfall a year. Only a narrow strip in the north has less than 80 inches (200 centimeters) a year. Temperatures average from 77 to 81 °F (25 to 27 °C) except in the extreme north, where a greater variation of temperature occurs.

Economy. Sierra Leone produces a wide variety of crops. But poor soil, the dry season, and the use of traditional farming methods keep yields low. Little effort is made to keep the soil fertile. As soon as the soil wears

Sierra Leone

WORLD BOOK maps

out on a plot, a farmer moves to a new area.

Rice is the main food crop. Farmers also grow oranges, peanuts, tomatoes, and *cassava* (a plant with roots similar to potatoes). For export, they raise coffee; ginger; *cacao* (seeds used to make chocolate); *kola nuts,* which are used to make soft drinks; and *palm kernels* (palm seeds that contain a valuable oil). Sierra Leone is the world's leading exporter of *piassava,* a fiber from the raffia palm used in making brushes. People catch large amounts of fish called *shad* along the coast.

Diamonds make up about half the total value of Sierra Leone's exports. The government tries to control the quantities of diamonds mined, but many people mine diamonds illegally and smuggle them out of the country.

Sierra Leone's mineral resources also include iron ore, bauxite, and rutile. Bauxite is used in making aluminum, and rutile contains the important metal titanium. Bauxite is Sierra Leone's second most important export.

Sierra Leone's only railroad line links the seacoast with iron ore deposits at Marampa. Most roads are unpaved, but they are fairly well maintained. Few people own a car. In rural areas, buses and pickup trucks fitted with rows of seats provide transportation. Buses and taxis operate in the cities. About 500 miles (800 kilometers) of rivers are navigable by small craft for three months each year. Freetown has an international airport.

History. Historians know little about Sierra Leone before 1460, when Portuguese sailors visited the area. In the 1500's, European trading ships began stopping there. The Europeans shipped many people from this area to America as slaves. About 1725, Fulani people who lived east of present-day Sierra Leone began a holy war to convert their neighbors to Islam. As the Fulani moved westward, many other peoples also migrated toward the coast and settled in what is now Sierra Leone.

In 1787, Granville Sharp, an Englishman opposed to slavery, settled about 400 freed black American slaves on land where Freetown now stands. The settlers suffered from hunger, disease, and warfare, and the settlement almost died out. The United Kingdom made the slave trade illegal in 1807. The next year, the British government made the Sierra Leone Peninsula a colony. The British freed slaves from the slave ships of many nations and settled them in the colony. British influence gradually spread inland. In 1896, the British established a protectorate over an area that, with the colony, had almost the same borders as present-day Sierra Leone.

Between 1896 and 1961, Sierra Leone moved gradually toward self-government. In 1961, it became completely independent. Sir Milton Margai became the first prime minister. Political leaders struggled for power after indecisive parliamentary elections in 1967. Army officers then took over the government. In 1968, the military government was overthrown. Siaka Stevens became head of a new civilian government. A new constitution adopted in 1978 made the All-People's Congress the only legal political party. Stevens remained head of the government until 1985. Major General Joseph Momoh, commander of the armed forces, succeeded him.

In 1991, Sierra Leone adopted a constitution that legalized opposition political parties. Multiparty elections were planned for 1992. But in April 1992, soldiers led by Captain Valentine Strasser overthrew Momoh, took control of the government, and canceled the elections.

Also in 1991, Corporal Foday Sankoh led an uprising against Momoh. After Momoh was overthrown by Strasser, Sankoh's forces, known as the Revolutionary United Front (RUF), began fighting the new government.

In early 1996, Sierra Leone held multiparty elections for president and parliament. Ahmad Tejan Kabbah was elected president. In 1997, a rebel group supported by the RUF ousted Kabbah and took over the government. In 1998, West African troops known as ECOMOG returned Kabbah to power. In 1999, Kabbah and Sankoh signed a peace agreement that gave Sankoh and other RUF members positions in the Sierra Leone government. In early 2000, United Nations (UN) peacekeeping forces replaced the ECOMOG troops. In May, RUF rebels seized about 500 UN peacekeepers and held them hostage for several weeks. Sankoh went into hiding, but was soon captured. The hostage crisis resulted in more fighting between the RUF and the government.

Between 1991 and 2001, about 50,000 people were killed in Sierra Leone's civil war. Hundreds of thousands of people were forced from their homes, and many became refugees in Guinea and Liberia. In 2001, UN forces moved into rebel-held areas and began to disarm rebel soldiers. By January 2002, the war was declared over. In May, Kabbah was reelected president. Samuel Decalo

See also **Freetown.**

Sierra Madre, *MAD ray,* is the name of three mountain ranges in Mexico—Sierra Madre Oriental, Sierra Madre Occidental, and Sierra Madre del Sur (see **Mexico** [terrain map]). The name *Sierra Madre* means *mother range* in Spanish. Peaks of the Sierra Madre Oriental rise about 13,000 feet (4,000 meters) above sea level. The Sierra Madre Occidental consists of rugged volcanic mountains usually reaching 7,500 to 10,000 feet (2,300 to 3,050 meters) high. The Sierra Madre del Sur rises to 11,500 feet (3,500 meters). *Sierra Madre* is also the name of mountain ranges in the Philippines and Wyoming. See also **Mexico** (picture). John J. Winberry

Sierra Nevada is a huge granite mountain range in eastern California. It is more than 400 miles (640 kilometers) long. Its width ranges from about 40 to 70 miles (64 to 110 kilometers). The range is gently tilted to the west. Close to its eastern edge are several peaks that rise more than 14,000 feet (4,270 meters). The highest is Mount Whitney (14,495 feet, or 4,418 meters). The Sierra Nevada covers about 30,000 square miles (78,000 square kilometers). See also **California** (Land regions; map); **Lake Tahoe; Mount Whitney; Sequoia National Park; Yosemite National Park.** Roger Barnett

Sieve of Eratosthenes, *ehr uh TAHS thuh neez,* is a method developed in the 200's B.C. by the Greek mathematician Eratosthenes for identifying *prime numbers.* These are numbers other than 1 that can be divided evenly by only 1 and themselves. Today, mathematicians use computers to identify prime numbers. But Eratosthenes's method, though much slower, always works.

To find prime numbers with the sieve of Eratosthenes, first write the series of whole numbers starting with 2. Cross out every second number after 2. This eliminates all numbers that can be divided evenly by 2, except for 2 itself. Similarly, cross out every third number after 3. (Include those numbers that you have already crossed out.) This step eliminates all the numbers that can be divided evenly by 3, except for 3 itself.

Then, since 4 is already crossed out, move on to 5. Cross out every fifth number after 5, and you have:

2 3 ~~4~~ 5 ~~6~~ 7 ~~8~~ 9 ~~10~~ 11 ~~12~~ 13 ~~14~~ 15 ~~16~~ 17 ~~18~~ 19 ~~20~~ 21 ~~22~~ 23 ~~24~~ 25 . . .

Continue this process for multiples of 7, and so on. Numbers that are not crossed out can be thought of as having passed through a *sieve* (strainer) that has caught all the rest.

Any number that has not been crossed out when you start with a number to its right—for example, the 3, when you begin a crossing-out step with 6—is prime. This process is endless because, as the Greek mathematician Euclid proved about 300 B.C., there is no largest prime number. Judith V. Grabiner

Sieyès, *syay YEHS,* **Emmanuel Joseph** (1748-1836), was a leader of the French Revolution (1789-1799). A priest, he was popularly known as Abbé Sieyès. Sieyès became famous for his 1789 pamphlet *What Is the Third Estate?,* which helped start the revolution.

By law, French society was divided into three groups called *estates.* Members of the clergy made up the first estate, nobles the second, and the rest of the people the third. In his pamphlet, Sieyès attacked the privileges of the nobility. He claimed the nobility monopolized all the advantages of society but did little of its work. At the beginning of the revolution, Sieyès worked to make the third estate the dominant force in French political and social reform.

Between 1789 and 1795, Sieyès served in several of a series of elected national legislatures—the Estates-General, the National Assembly, and the National Convention. As a legislator, Sieyès was a moderate liberal and specialized in constitutional questions.

In 1799, Sieyès was elected to a five-man Directory, which had begun ruling France in 1795. As a Directory member, Sieyès helped engineer a *coup d'état* (revolt against the government) as a means of ending the turmoil of the French Revolution. The coup brought Napoleon Bonaparte to power and ended the revolution. Sieyès was born in Fréjus. Isser Woloch

Sifaka. See Lemur.

Sight. See Eye.

Sigismund, *SIHJ ihs muhnd* or *SIHG ihs muhnd* (1368-1437), was Holy Roman emperor from 1410 until his death. He also ruled as king of both Hungary and Bohemia. Sigismund helped end the *Great Schism,* a dispute in the Roman Catholic Church involving rival popes (see **Pope** [The troubles of the papacy]).

Sigismund was born in Nuremberg, Germany. He was the son of Holy Roman Emperor Charles IV. Sigismund was crowned king of Hungary in 1387. After he was elected Holy Roman emperor, Sigismund brought about the Council of Constance, a meeting of Catholic leaders. Sigismund was a leading force at the council, which settled the Great Schism in 1417 and elected Martin V as pope.

In 1420, Sigismund was crowned king of Bohemia. However, he was expelled by followers of John Hus, a Bohemian religious reformer who had been condemned to death by the Council of Constance. Sigismund had guaranteed Hus's safety but later approved his execution (see **Hus, John**). The Bohemians recognized Sigismund as king in 1436 after he agreed to demands on some church matters. Charles W. Ingrao

Sigma Xi, *SIHG muh ZY,* is an honorary scientific society. It was founded at Cornell University in 1886 to encourage study in the pure and applied sciences. Members of the society include people who have done important scientific work. University students who are qualified may be elected to associate membership in the society.

Sigma Xi has about 260 chapters and about 240 local clubs in the United States and in other countries. There are about 110,000 members who are actively associated with the society. Each year, Sigma Xi awards about 1,000 research grants to young scientists. It also publishes a magazine called *American Scientist.* The society's address is P.O. Box 13975, Research Triangle Park, NC 27709. Critically reviewed by Sigma Xi

Sign language is a language of gestures and hand symbols. Deaf and hearing-impaired people use sign language. People with normal hearing also use it to communicate with deaf and hearing-impaired people.

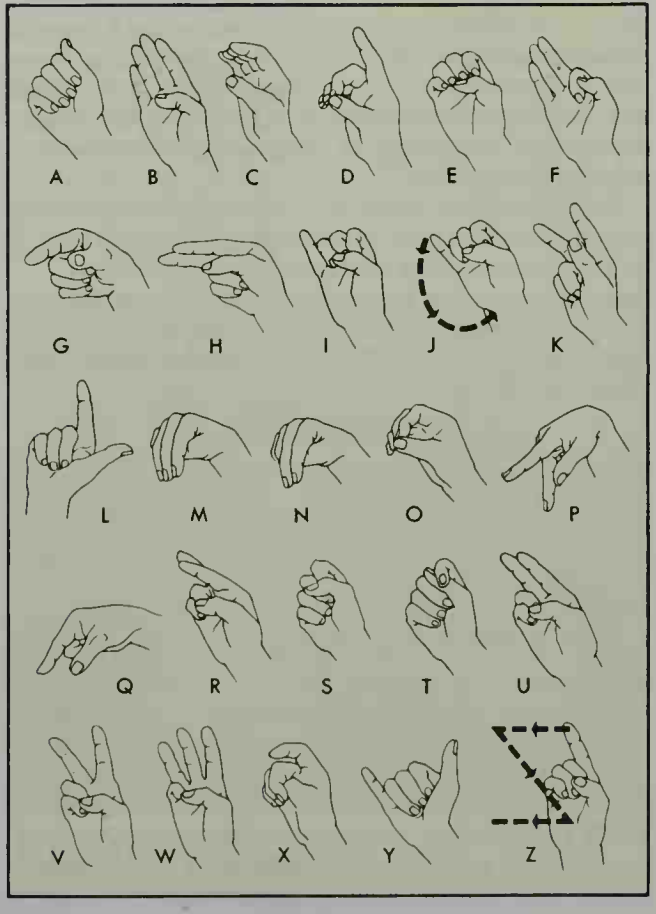
Many deaf people in the United States use American Sign Language (ASL). ASL is based on ideas rather than words. Each gesture expresses a particular idea or concept. For example, one gesture can be used to express the idea that something has been used up, such as money, time, or patience.

Some words and names do not have equivalents in

The American manual alphabet

The American manual alphabet is a form of sign language used by deaf and hearing-impaired people. People with normal hearing can also use this method to communicate with deaf and hearing-impaired people. Each letter of the alphabet is represented by a different position of the fingers to spell out words.

WORLD BOOK illustrations



Commons Theater (WORLD BOOK photo by Steinkamp/Ballogg)

Actors use sign language in this scene from a play about a deaf baseball player. Some theater companies give special signed performances for deaf and hearing-impaired people.

American Sign Language. For these words, the American manual alphabet—also known as the *finger alphabet*—may be used. This system contains 26 hand symbols, one for each letter of the alphabet. The hand symbols are used to finger-spell words. They are also used in combination with gestures for specific words or names.

When deaf people communicate with each other, they often use ASL. When communicating with hearing people, they try to modify their signing so that it more closely follows English word order. Many schools use a philosophy called *total communication*. This term means that every type of communication, including ASL, lip reading, and oral speech, is used as needed to express information and ideas.

The first deaf person to teach other deaf people in the United States was a Frenchman, Laurent Clerc. In 1816, he came to the United States to help set up the first American school for the deaf, which opened in Hartford, Connecticut, in 1817. Willard J. Madsen

See also **Deafness; Indian, American** (Language; illustration: Indian sign language).

Additional resources

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Proctor, Claude O. *Signing in Fourteen Languages.* Black Dog & Leventhal, 2000. A multilingual sign language dictionary.

Signaling is one way of passing information from one person or place to another. Signals are used when direct and unaided voice or direct written communication is impossible or undesirable.

There are three main forms of signals: (1) electrical, (2) visual, and (3) sound. Various electrical, mechanical, and hand devices are used to transmit signals. International codes—such as the International Morse Code and the international flag code—have been developed for some kinds of signals. Such signals are the same throughout the world and can be understood anywhere. For more information on these, see **Flag** (Flags that talk); **Morse code**.

Methods of signaling

Visual and sound signals of one kind or another have been used since ancient times. Early methods included trumpet sounding, drum beating, flag and smoke signals, and beacon fires. Electrical signals were first used in the early 1800's.

Visual and sound signals still have many uses today. People create sound signals with a variety of devices. These devices include bells, guns, horns, sirens, and whistles.

Visual signals are often made with flags. *Semaphore signaling* is done with two hand flags. The sender holds the flags in various positions to represent the letters of the alphabet and to give several other meanings. *Flag hoist signals* are made by hanging colored flags from crosspieces on the masts of ships.

Visual signaling can be done with colored lights, with each light having a different meaning. Lights are often flashed or blinked according to some code. Signals also may be passed by reflecting sunlight with mirrors. Fireworks used for signals include rockets, flares, smoke, and cartridges or shells fired from guns.

Electrical signals can be transmitted in various ways. These include fax machine, radio, radar, television, telegraph, and telephone. Communications satellites are used to carry electrical communication to any part of the world. Coaxial cables are also used to carry several types of electrical communication. Fiber-optic systems translate electrical signals into flashes of light. These flashes of light are transmitted through transparent fibers of glass or plastic.

Important uses of signals

Throughout history, signals have been used in a wide range of activities. This article discusses only a few important uses. For information on other uses of signals, read the separate articles listed in the *Related articles* at the end of this article.

Military signaling. Armies use signals in such electrical communications as radio, radar, telephone, and television. In addition, armies use messengers and visual and sound signals. Visual signals include arm and hand signals, hand flags, panels, lights, and fireworks. Sound signals include horns, gunshots, and whistles.

Aircraft signaling. Radio signals are passed between ground stations and aircraft providing instructions for take-off and landing, the position of other planes, and weather information. In addition, some airplanes are equipped with an *automatic direction finder,* or radio compass, and use omnidirectional radio range equipment. This equipment enables pilots to locate their position at all times. Radar is used to guide aircraft to safe landings in any kind of weather and to guide military aircraft to their targets. Visual signals used to aid pilots include beacons, running lights, wind socks, and approach lights.

Marine signaling. Various means of electrical communication are used by both commercial and naval ves-

sels. Radio is used extensively in ship-to-ship communication, and for controlling naval aircraft. Radio also connects ships at sea with stations ashore. Radar helps reveal the position of ships. Enemy submarines and explosive mines can also be detected by an echo-sounding device called *sonar.*

Lights, semaphore flags, and flag hoists are the most common means of visual signaling at sea. Sound signals include electrical sound-producing devices and bells, gongs, and whistles on *buoys* (floating markers) that are operated by the motion of the sea. Lights and fog signals on lighthouses, lightships, and buoys warn that ships are approaching land or dangerous hidden objects.

Distress signals. A ship or aircraft in need of help can send several internationally agreed upon distress signals. Two of the best known are the radio signal *SOS* in code, which is used at sea, and the aircraft call of *Mayday* sent over voice radio. Other well-known distress signals include a gun fired at short intervals; a continuous sounding of fog signals; colored flares thrown from shells or rockets; the international flag signal *NC;* and flying the national flag upside down. Carol E. Stokes

Related articles in *World Book* include:

Illustrations of signals

The following articles include illustrations of various methods of signaling:

Basketball
Boating
Communication
Deafness
Flag
Football
Indian, American
Railroad (Traffic control; diagram)
Sign language

Other related articles

Beacon
Codes and ciphers
Fireworks
Heliograph
Lighthouse
Morse code
Radio (Uses)
Semaphore
SOS
Traffic
Whistle

Sigurd, *SIHG urd,* is the Scandinavian name for the legendary German hero Siegfried. Stories about him probably originated in the A.D. 400's and soon reached Scandinavia. They were given poetic treatment in the *Elder Edda,* a collection of poems composed in Iceland during the 1000's and 1100's. The prose *Saga of the Volsungs,* written in Iceland during the 1100's or 1200's, tells the stories more fully. See also **Edda; Nibelungenlied; Siegfried.** Richard N. Ringler

Sikhism, *SEE kihz uhm,* is one of the religions of India. Its believers call themselves *Sikhs,* which means *disciples.* Sikhs follow the teachings of 10 *gurus* (spiritual teachers). The Sikh holy book, the *Adi Granth* (First Book), includes the teachings of some of these gurus and other Sikh teachers, hymns, and poetry. About 14 million Sikhs live in India, the majority of them in the northern state of Punjab.

The first Sikh guru, Nanak, was born into a Hindu family in 1469. Nanak preached that there is one God who is the invisible creator and present everywhere. Nanak criticized Hindu and Muslim religious practices that he said emphasized outer forms over inner spiritual awakening. He instructed his followers to be aware of God's presence by rising early, bathing, meditating on the divine name, and directing each day's activities to God. By remembering God in this way, and by living a good and simple life, people could free themselves from the cycle of *reincarnation* (see **Reincarnation**). According to Sikh belief, a person's actions (*karma*) determine whether the soul will enter the next life as a plant, animal, or human being. Only someone who reaches a higher state of spiritual development can be free from experiencing further earthly lives.

In 1526, northern India was conquered by Muslims from what is now Afghanistan, who founded the Mogul Empire. By the time of the 10th guru, Gobind Singh, the Sikhs had to defend themselves from Muslim persecution. In 1699, Gobind Singh organized his followers into a military order called the *Khalsa* (Pure). Sikh men and women were initiated into the Khalsa by sharing a drink of sweetened water called *amrit,* a symbol of their loyalty to the guru and their hope for a higher spiritual existence. The ideal of the true Sikh became the "saint-soldier" of the Khalsa who combines the virtues taught by Nanak and Gobind. Gobind also declared that after his death the guru would be the Adi Granth, and formally named it the *Guru Granth Sahib* (Book of God).

In the early 1800's, the Sikh ruler Ranjit Singh established a Sikh kingdom in northern India (see **Ranjit Singh**). In 1849, the kingdom was conquered by the British, who controlled much of India. When India and Pakistan became independent nations in 1947, almost half the Sikhs lived in the area that became Pakistan. Many Sikhs fled to India to escape persecution.

By the 1960's, the Sikh community was playing a leading role in India's agriculture, business and professional work, and military life. Sikh farmers led the "green revolution" that helped increase India's food production. In 1966, India made the state of Punjab smaller, leaving the Sikhs in the majority. Anandpur, where the Khalsa was founded, and the holy city of Amritsar lie in Punjab. See **Amritsar; Punjab.**

The symbol of Sikhism consists of two curved swords, a double-edged dagger, and a discus. The symbol stands for bravery and spiritual power.

Steve Maines, Stock, Boston

The holiest Sikh shrine is the Golden Temple in the sacred city of Amritsar, India. Ram Das, the fourth Sikh guru, founded the city in 1577 and built a pool around the temple.

Many Sikhs demanded more control of Punjab. In 1984, Sikh rebels occupied the Golden Temple and the surrounding sacred buildings in Amritsar. An Indian army action to remove the Sikhs caused great damage and many deaths. Some radical Sikh groups continued to carry out acts of violence and terrorism as part of their movement. However, a police crackdown in the early 1990's led to a decrease in the violence in 1993.

Gene R. Thursby

Additional resources

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Grewal, J. S. *The Sikhs of the Punjab.* Cambridge, 1990.
Kaur-Singh, Kanwaljit. *Sikhism.* Thomson Learning, 1995. Younger readers.
Singh, Patwant. *The Sikhs.* Knopf, 2000.

Sikkim, *SIHK ihm,* is an Indian state tucked away in the towering mountains of south-central Asia. It lies in northern India, in the heart of the high Himalaya. For location, see **India** (political map). Mount Kanchenjunga, the third highest mountain in the world, lies on Sikkim's western border with Nepal. China lies to the north of Sikkim. An arc of mountain peaks in the east separates Sikkim from China and Bhutan.

Sikkim covers 2,740 square miles (7,096 square kilometers). Its geography ranges from snow-covered mountains more than 28,000 feet (8,530 meters) high to a thick, tropical rain forest that lies at sea level.

Formerly a monarchy and a protectorate of India, Sikkim became an Indian state in 1975. Its population is 540,493. Gangtok is the capital and only city. As in other Indian states, a governor serves as head of Sikkim's government. The president of India appoints the governor. Sikkim also has a 32-member legislature elected by the people. The head of the majority party in the state legislature serves as the chief minister of Sikkim.

People. Nepalese, Lepchas, and Bhutias make up most of Sikkim's population. Many Nepalese moved to Sikkim after 1890. Today, they make up about 70 percent of the population. Most of them live on small farms in the middle altitudes in the southern part of the state. The farmers work with simple hand tools.

The Lepchas, first settlers in Sikkim, were pushed aside by later settlers. Today, they live in distant valleys. Many hunt and fish for food, and others farm or raise livestock. In some areas, Nepalese farmers have cleared many forests to plant crops. This has destroyed the hunting grounds of the Lepchas and has caused trouble between the two groups.

The Bhutias came to Sikkim from Bhutan and Tibet in the 1600's. Today, they herd cattle and *yaks* (Asian oxen). In the summer, they live in tents and graze their herds in high mountain meadows. In the winter, they live in wooden houses in the highlands.

Lepchas and Bhutias practice Tibetan Buddhism. Over half of the people, including most of the Nepalese, are Hindus. But their Hinduism has been influenced by Buddhism. Most of the Nepalese in Sikkim speak Gurkhali. The majority of Lepchas and Bhutias speak Sikkimese. English is also used. About 2 out of 10 people in Sikkim can read and write.

Land. People cannot live in many parts of Sikkim, because the mountain land is too rocky and barren. Over thousands of years, the streams flowing down the mountains into the Tista River have cut into the mountainsides and formed a basin in south-central Sikkim. This basin is 40 miles (64 kilometers) wide.

The highest mountain peaks are covered with snow all year. The lower slopes have cool, grassy meadows. Still farther down are warm forests and hot, rainy areas. Tropical rain forests grow in the southern river valley bottoms, where heavy rains fall. Rainfall in Sikkim varies from 200 inches (500 centimeters) to less than 40 inches (100 centimeters) a year.

Economy. Sikkim's economy is based on agriculture, and most of the people are farmers. Some farmers raise rice, corn, and other cereal crops to feed the people. Others raise apples, *cardamom* (a spice), citrus fruits, pineapples, and potatoes. Handicrafts provide the chief industry. Craftworkers weave cloth, blankets, and rugs, and make copperware and woodcarvings.

Many of Sikkim's roads are poor. About 300 miles (480 kilometers) of roads link Sikkim with other parts of India. Sikkim has no railroads or airports.

Forests cover almost a third of Sikkim. The state has some copper, lead, and zinc deposits.

History. Sikkim became an independent monarchy about 1640, when Penchu Namgyal was crowned *chogyal* (king). Sikkim then controlled lands that are now part of Bhutan, China, India, and Nepal. In 1780, warriors from Nepal and Bhutan invaded Sikkim and seized much of the land. The United Kingdom (U.K.) defeated the Nepalese in 1814 and restored some land to Sikkim.

In 1861, the U.K. made Sikkim a protectorate, and a British official later took over much of the chogyal's power. By 1918, the chogyal had regained control of internal matters.

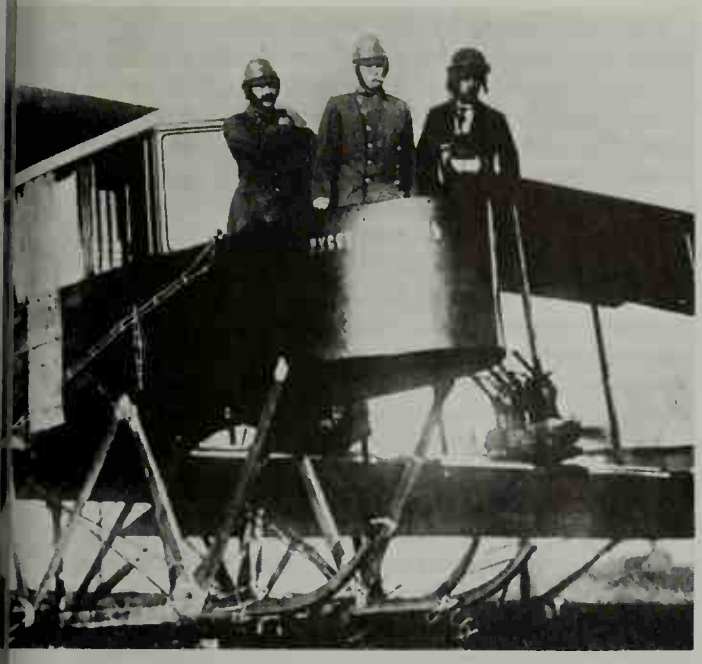
The United Kingdom gave India control over Sikkim in 1947. In 1950, Sikkim agreed to Indian control of its defense, foreign relations, and vital communications. In 1963, Chogyal Palden Thondup Namgyal married Hope Cooke, an American. She left Sikkim in 1973 and went to New York to live. That year, antigovernment demonstrations led the chogyal to accept some political reforms that reduced his power.

India gradually gained more and more control over Sikkim's affairs. In April 1975, Sikkim's legislature voted to become a state of India, in spite of opposition from the chogyal. A special referendum was then held, and Sikkimese voters approved the proposed statehood by a large margin. Sikkim ended more than 300 years as a monarchy in May 1975, when it officially became a state of India.

Robert LaPorte, Jr.

Sikorsky, *sih KAWR skee,* Igor Ivanovich, *EE gawr ih VA nuh vyihch* (1889-1972), an aircraft designer and manufacturer, pioneered in multiengine airplanes, helicopters, and transoceanic flying boats. He designed the world's first four-engine aircraft in 1913. He produced a successful single-rotor helicopter in 1939 (see **Helicopter** [The first practical helicopters; picture]).

Sikorsky was born on May 25, 1889, in Kiev, Russia. He was educated at the Petrograd Naval College and at engineering schools in Paris and Kiev. He first attempted to build helicopters but failed because he lacked suitable engines. He then concentrated on fixed-wing aircraft and rose to prominence in Russian aviation, designing one of the most successful bombers of World War I (1914-1918). Sikorsky came to the United States in 1919.



Brown Bros.

Igor Sikorsky, *right,* built and piloted the first successful four-engine airplane in 1913.

In 1923, he founded a company that produced flying boats and pioneered passenger routes in the Caribbean Sea and across the Pacific Ocean. In 1934, this company became part of the United Aircraft Corporation (now United Technologies Corporation). Sikorsky then turned to the design and building of helicopters.

Roger E. Bilstein

See also **Airplane** (Other pioneer planes and fliers).

Silesia, *sih LEE zhuh,* is a region in southwestern Poland, eastern Germany, and northern Czech Republic. It includes the upper Oder River Valley and the Sudeten Mountains. It covers about 19,000 square miles (49,000 square kilometers) and has a population of about 10 million. Katowice and Wrocław, Poland, are the main cities. Silesia manufactures machinery, metals, and other products. Its minerals include coal and iron. Farmers grow grains, potatoes, and sugar beets.

The region became part of Poland in the 900's. Austria took over Silesia in 1526, and Prussia seized northern Silesia from Austria in 1742. In 1919, after World War I, Germany and Poland divided northern Silesia, and southern Silesia became part of Czechoslovakia. Poland gained control of the entire northern part in 1945, after World War II. In 1993, the Czechoslovak section became part of the Czech Republic. Janusz Bugajski

Silica, *SIHL uh kuh,* is silicon dioxide, a chemical compound consisting of silicon and oxygen. Its chemical formula is SiO_2. Quartz and a few other minerals consist entirely of silica. Silica occurs in two forms, *crystalline* and *amorphous.* Crystalline varieties of silica, which include coesite, cristobalite, quartz, and stishovite, have a definite crystal structure. Amorphous silica forms, such as lechatelierite and opal, have no such structure.

Silica minerals have many uses. For example, quartz crystals serve as part of the transmitting equipment of radios and most kinds of radar. Certain lenses are made from quartz. Quartz crystals also are used in various kinds of watches. Several varieties of quartz and opals are cut and polished as gemstones. Mary Emma Wagner

Related articles in *World Book* include:

Ceramics	Glass	Opal	Silica gel
Feldspar	Mica	Quartz	Silicosis

Silica gel, *SIHL uh kuh jehl,* is a sandlike substance widely used as a demoisturizer. Each particle of silica gel has many small pores and thus a relatively large surface area. As a result, silica gel can *adsorb* (collect) large amounts of water vapor and certain other gases.

Silica gel has many uses. Small packets of it are packaged with certain foods to reduce moisture and preserve freshness. Manufacturers also use silica gel in making inks, paints, and *catalysts.* Catalysts are substances that speed up chemical reactions in pollution control systems and in petroleum refining.

Silica gel contains hydrogen, oxygen, and silicon. It is made by adding an acid to a solution of a compound called *sodium silicate.* Kenneth Schug

Silicate, *SIHL uh kiht* or *SIHL uh kayt,* is any of a group of minerals that contain silicon, oxygen, and one or more metallic elements. Silicates make up about 95 percent of the earth's crust. Soil consists chiefly of silicates, as do most rocks.

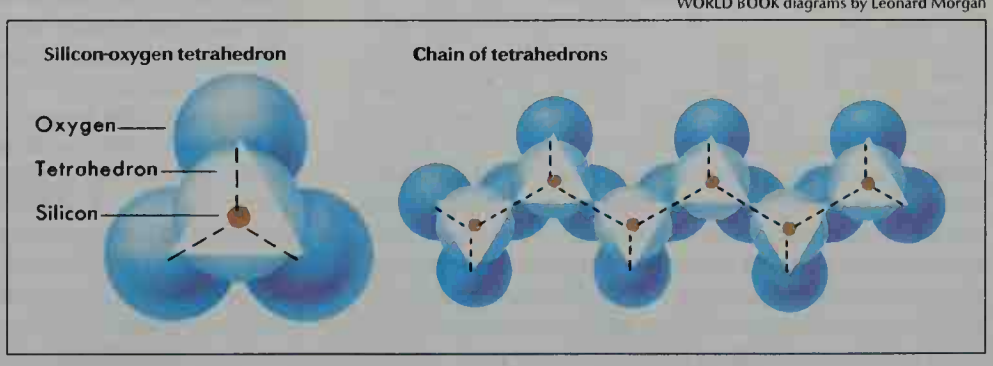
All silicates have a crystal structure composed of units called *silicon-oxygen tetrahedrons.* Each of these units consists of one silicon ion surrounded by four oxygen ions, which form a pyramidlike figure with four triangular faces—that is, a tetrahedron. Such units may exist independently. But they also may be linked with others, forming more complex structures. These complex structures, in turn, may be loosely held together by *cations* (positively charged atoms) of aluminum, iron, or other metals present in a given silicate mineral.

Silicates are classified according to the way their silicon-oxygen (SiO_4) units are arranged. An *independent tetrahedral silicate* consists of isolated groups of SiO4 tetrahedrons held together by metal cations. Olivine is a mineral of this type. A *double tetrahedral silicate* is com-

WORLD BOOK diagrams by Leonard Morgan

Silicate crystal structure

Silicate minerals have a structure comprised of units called *silicon-oxygen tetrahedrons.* Each of these units consists of one silicon ion surrounded by four oxygen ions, which form a pyramidlike figure. Such units may exist independently, *right,* or they may be joined together as a chain, *far right,* and other more complex structures.



posed of two tetrahedral groups. The mineral epidote contains such double tetrahedrons. A *ring silicate* consists primarily of rings of three or six tetrahedrons. The mineral beryl is an example of a six-membered ring silicate. A *chain silicate* has many tetrahedrons linked in either single or double chains. Amphiboles and pyroxenes are chain silicates. A *sheet silicate,* such as mica, consists of sheets of tetrahedrons with metal cations sandwiched between them. A *framework silicate* is comprised of tetrahedrons linked in three-dimensional networks that extend in all directions. Feldspar and quartz, the most abundant minerals in the earth's crust, belong to the framework silicate group. William B. Simmons, Jr.

Silicon is a hard, dark gray element with a metallic luster. Silicon is a *semiconductor,* a material that conducts electric current better than an insulator like glass, but not as well as a conductor like copper.

Silicon's *atomic number* (number of protons) is 14. Its *relative atomic mass*—that is, its *mass* (amount of matter) compared with that of carbon 12, the most common form of carbon—is 28.0855 unified atomic mass units (u). By agreement, 1 u is $\frac{1}{12}$ the mass of one atom of carbon 12. Silicon has a density of 2.33 grams per cubic centimeter. It melts at a temperature of 1410 °C and boils at 2355 °C. Its chemical symbol is Si. The Swedish chemist Jöns J. Berzelius discovered silicon in 1823.

Silicon makes up about 28 percent of Earth's crust. Only oxygen is more plentiful. In nature, silicon occurs primarily in silicon dioxide (SiO_2), also known as *silica,* and in compounds known as *silicates.* A silicate contains (1) units of one silicon atom and four oxygen atoms (SiO_4), and (2) one or more metallic elements.

SiO_2 is the main ingredient of sand, quartz, agate, and glass. It is used in optical fibers, ceramic products, and the quartz crystals in electronic devices. Most rocks are mineral silicates. Silicates are the principal building material in the world in the form of cut stone, bricks, and concrete. Many gemstones are SiO_2 or SiO_4 minerals.

Silicon carbide (SiC), also known by the trade name *Carborundum,* is a compound with carbon that ranks as one of the hardest materials known. Manufacturers use it to grind and polish other materials. *Silicones,* synthetic compounds with carbon and oxygen, are used in synthetic rubber, water repellent coatings, nonstick surfaces, lubricants, electrical insulators, and sealants.

Silicon is the main substance in computer chips, solar cells, transistors, and other electronic devices. Extremely pure silicon is modified in two ways: (1) with small amounts of other elements to provide certain electrical properties, and (2) with oxygen to make insulating SiO_2. Emily Jane Rose

Related articles in *World Book* include:
Computer chip
Semiconductor
Silica
Silicate
Silicone
Solar energy (Photovoltaic conversion)
Transistor (Transistor materials)

Silicone, *SIHL uh kohn,* is any of a group of synthetic materials. It is unlike anything found in nature. Silicones are a cross between organic materials such as oil, rubber, and plastics; and inorganic materials such as sand, glass, and quartz. Their key material is the element silicon. Except for oxygen, silicon is the most abundant material in the earth's crust.

Uses. Silicones, which come in solid, liquid, and gaseous forms, have thousands of uses. As release agents, silicones keep bread from sticking to pans in commercial bakeries. Clean and smokeless, they work better than grease. Silicones also keep tires and other rubber and plastic parts from sticking in the molds. Silicone fluids are used in waxes and polishing agents for automobiles, furniture, and eyeglasses. Fabric and leather that is treated with silicone will not absorb water or water-based products such as ink and tomato juice. Repeated washing or dry cleaning will not remove the silicone. Yet silicone will not stiffen the fabric.

Many silicones are not harmful to the human body. They also are not affected by chemicals in the body. For these reasons, they are used in making artificial human parts, including heart valves, that can be permanently implanted in the body.

Silicone oils and greases serve as permanent lubricants for clocks and ball bearings. Silicone water repellents keep brick and concrete walls dry in the rain. Silicones are also widely used as waterproof sealants around windows and for bathroom and kitchen tiles. Paints made with silicone resins do not blister and peel off at temperatures of 500 °F to 1000 °F (260 °C to 540 °C). In addition, outdoor weathering does not make them lose their gloss and color. Silicones are also used as electrical insulating materials.

Silicone rubber does not melt at oven temperatures or become hard and brittle at temperatures as low as −110 °F (−79 °C). It is used to seal oven doors and rocker boxes on aircraft and tank engines. Silicone rubber insulates communications cables on ships and motor coils in diesel-electric locomotives.

Composition. The amount of heat, weathering, and aging a material can withstand is partly due to the strength of the bonds that hold together the atoms which make up the material. Like sand and glass, silicones have a molecular skeleton of alternating atoms of silicon and oxygen. The bonds between silicon and oxygen atoms are about 1 $\frac{1}{2}$ times as strong as those between carbon atoms in organic materials. As a result, silicones are several times more resistant to heat and weathering than are organic materials.

In addition, silicones, unlike sand and glass, have various organic groups attached to the silicon-oxygen skeleton. Together, these structures provide the heat stability, water repellency, lubricating properties, and flexibility required in a number of household and industrial applications. Marvis E. Hartman

Silicosis is a lung disease caused by inhaling crystalline silica dust. Exposure to silica dust—and thus the risk of contracting silicosis—is especially high among iron and steel foundry workers, sandblasters, rock drillers, miners, and workers who produce pottery, glass, and abrasives.

There are three forms of silicosis: *simple, complicated,* and *acute.* After a particle of silica is inhaled, it eventually becomes surrounded by fibrous scar tissue. The scar tissue forms a small *nodule* (lump) in the lung. Simple silicosis is recognized by the presence of many small nodules on a chest X ray. It usually takes 10 to 20 years to develop. Simple silicosis generally does not affect the function of the lungs. It may, however, progress to complicated silicosis (also called progressive massive

fibrosis), in which nodules cluster together to form masses of fibrous tissue. When more than about a third of a lung becomes fibrous, the patient experiences shortness of breath and abnormal lung function. Complicated silicosis sometimes leads to death. Acute silicosis develops much more rapidly than complicated silicosis and is usually fatal in two or three years. It causes the air sacs of the lungs to fill with fluid. It may occur in workers exposed to high concentrations of silica dust, such as sandblasters and rock drillers.

There is no effective treatment for silicosis. Prevention is best achieved by using ventilation systems and engineering techniques that limit silica dust exposure in the workplace. Michael G. Levitzky

Silk is a strong, shiny *fiber* (threadlike substance) that is used to make cloth. Silk has a natural beauty that few other fibers can equal and is often called the *queen of fibers.* Silk fiber is made from the cocoons of caterpillars called *silkworms.* Many other animals, including spiders and lacewings, spin silk threads. But their silk cannot economically be made into cloth.

Silk is the strongest of all natural fibers. A thread of silk is stronger than the same size thread of some kinds of steel. Silk is also highly elastic. It can be stretched and will still return to its original shape. Silk garments are extremely light in weight, and are warmer than cotton, linen, or rayon clothing. Dyed silk cloth has a deeper, richer appearance than most other dyed fabrics. Silk fabric can be ironed easily, and it resists wrinkling.

Silk is used widely in making men's and women's clothing. It is also used in upholstery and curtain materials, especially in mixed fabrics.

China produces more raw silk than any other country. Japan ranks second. Other leading silk producers include Brazil, India, South Korea, Thailand, and Uzbekistan. The United States is the world's leading manufacturer of silk products.

Sources of silk

Cultivated silk is spun by silkworms that are raised on silk farms. Almost all commercial silk is cultivated. Most high quality cultivated silk is produced by the caterpillars, or larvae, of a moth called *Bombyx mori.* The first part of its name comes from *Bombycidae,* the family of moths to which it belongs. The last part comes from *Morus multicaulis,* the scientific name of the mulberry tree, on which it feeds.

The *Bombyx mori* is a rather large white moth, with black-lined wings. From wing tip to wing tip, the moth measures a little more than 2 inches (5 centimeters). Its body is short and thick, and its legs are stout.

Wild silk, called *tussah,* comes from silkworms that feed chiefly on oak leaves. These worms grow wild, mainly in China and India. Tussah is difficult to bleach because its natural color is tan or brown. It is less shiny than cultivated silk. Tussah is used as a filling in fabrics and is often blended with other fibers.

Raising silkworms

The raising of silkworms requires a great deal of care and patience. Silk farmers treat the *Bombyx mori* as carefully as they would a newborn baby. They raise it under carefully controlled temperatures. They protect it from flies and diseases that may destroy the silkworm.

Eastfoto

The luxurious qualities of silk have earned it the nickname *queen of fibers.* Dyed silk fabric has a radiant beauty that makes it a popular material for fashionable clothing.

Production of silkworms. In early summer, a female *Bombyx mori* lays from 300 to 500 eggs. It deposits them on special strips of paper provided by the silk farmer. The moth dies soon after it lays its eggs. The eggs undergo many tests to make sure they contain perfect, disease-free worms. Then they are put in cold storage. Early the next spring, the silk farmer puts the eggs in an incubator. An *incubator* is a device for keeping the eggs at a suitable temperature for hatching. About 20 days later, the eggs hatch into tiny silkworms.

Development of silkworms. The young silkworms are put on trays that are kept spotlessly clean to prevent disease. At first, the silkworms have enormous appetites. They eat almost continually, both night and day. The silk farmer supplies them with fresh mulberry leaves every two or three hours. The worms grow to about 70 times their original size and shed their skins four times. After four to five weeks, the silkworm is about 3 inches (8 centimeters) long and nearly 1 inch (2.5 centimeters) thick. It has a head, 13 body segments, 3 pairs of true legs, and usually 5 pairs of leglike *prolegs* farther back on its body.

Spinning the cocoon. When fully grown, the silkworm stops eating and is ready to spin its *cocoon* (outer wrapping). The worm creeps into a tiny wooden compartment containing twigs or stems of straw that the farmer has prepared. The worm spins a net or web to hold itself to a twig or stem. It then forms a cocoon, which is the silk. To do this, it swings its head from side to side in a series of figure-eight movements. Two glands near the silkworm's lower jaw give off a fluid that hardens into fine silk threads as it hits the air. At the same time, it gives off a gum called *sericin.* The sericin cements the two threads of silk together.

The silkworm spins the silk around and around its body, until all the fluid has been used. After about three days of spinning, the cocoon is completed. The worm then changes into a *pupa,* which is the third stage of its life cycle. The pupa becomes a moth in about three

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Factory workers sort cocoons before beginning the process of *reeling* (unwinding) the long delicate threads. The threads of several cocoons are drawn together to form a strand strong enough for commercial use.

weeks, thus completing its life cycle, or *metamorphosis* (see Metamorphosis).

When a pupa changes into a moth, it bursts the cocoon and breaks the long silk thread into many short ones. For this reason, silk farmers allow only a small percentage of pupas to develop into moths. These moths are kept to lay the next batch of eggs. To save the silk, the other insects are killed before they break their covering. Silk farmers usually kill the insects by placing the cocoons in a hot oven.

Processing silk

Reeling. After the pupa has been killed, silk workers are ready to *reel* (unwind) the long delicate threads of the cocoon. This is done in a reeling factory called a *filature*. The cocoons are soaked in basins of hot water to dissolve the gummy sericin that holds the threads together. As the cocoons bob about in the basin, their *filaments* (slender threads) are drawn together and pulled by pulleys through a tiny porcelain *guide*. The guide is much like the eye of a needle.

The melted sericin glues several silk filaments into a single thread, which is wound onto a reel. Threads from several cocoons are reeled at the same time, because a single filament is far too fine to be wound onto a reel separately. Later, the silk is removed from the reel and twisted into *skeins* (small coiled bundles). Thirty skeins are bound into a large bundle called a *book*. A bale of raw silk ready to be shipped to a mill for weaving contains about 30 books and weighs about 135 pounds (61 kilograms).

Throwing. The raw silk is now much stronger than it was when it left the cocoon. But it is still not strong enough to be woven into anything except the sheerest material. It is strengthened by a series of processes called *throwing*. The term comes from the Anglo-Saxon word *thraw* (twist). Throwing is increasing the twist or adding strands and twisting them together.

The number of threads thrown together depends on the fabric to be woven. Most raw silk used to make the *woof* (crosswise threads) is thrown with a certain twist. But much silk used for the *warp* (lengthwise threads) is reeled in heavier sizes, and need not be thrown.

Boiling off and weighting. When the silk comes from the throwing machines, there is still sericin on it. Workers boil the silk in a solution of hot soap to remove the sericin. This process is called *boiling off*. The removal of the sericin uncovers the natural beauty of the silk. Boiled-off silk is usually milky-white. The sericin can be removed either before or after weaving, depending on the type of fabric. Boiling off causes the silk to lose about 25 per cent of its weight. Before World War II, silk fabrics were often *weighted* (loaded) with mineral salts to make up for this loss in weight. But heavily weighted silk cracks and tears much more easily than *pure-dye* silk. In 1938, the U.S. Federal Trade Commission established strict trade-practice rules for the silk industry. To be labeled as pure-dye silk, garments dyed black may be weighted up to 15 per cent, and other colors up to 10 per cent. Garments with more weighting must be labeled as weighted silk.

Dyeing. Brilliant dyes may be applied to silk yarn before it is woven. This type of dyeing is called *skein dyeing*. Some silk fabrics are dyed after they are woven. This process is called *piece dyeing*.

Weaving. Silk yarns are woven on looms much like those used for cotton and wool. Automatic power looms have replaced hand-weaving methods in almost all countries. Many silk fabrics, including damasks and heavy evening-wear fabrics, are woven on Jacquard looms. Beautiful designs or patterns can be woven on these looms.

Douppioni are uneven, double silk threads. The double threads come from two silkworms that have nested together and spun a single cocoon around them. In processing, the double threads are not separated. Fabrics woven from douppioni thread have a knotted or twisted appearance. Douppioni are used for the filling in

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Spools of silk thread in a Chinese factory are wrapped before they are shipped to a mill and woven. China produces more raw silk than any other country.

The silk cycle

The making of a fine silk garment completes a long process that includes the life cycle of the silkworm. During this process, the silkworm's delicate cocoon is made into silk thread, which is woven into beautiful silk fabric.

© Harry Rogers, Photo Researchers

1. A silkworm moth

©Harry Rogers, Photo Researchers

2. Moth laying eggs

© Gilbert Grant, Photo Researchers

3. Young silkworms feeding

© Tom McHugh, Photo Researchers

4. A full-grown silkworm

© Stephen Dalton, Photo Researchers

5. A silkworm making a cocoon

© Stephen Dalton, Photo Researchers

6. A completed silk cocoon

© Lowell Georgia, Photo Researchers

7. Spools of silk thread

© Audrey Topping, Photo Researchers

8. Finished silk cloth

rough weave textiles, such as shantungs.

Spun silk. Not all silk can be reeled and thrown for weaving. When a moth bursts its cocoon, it breaks the one long filament into several short ones. These pierced cocoons and the beginnings and ends of reeled-off cocoons are silk *wastes*. These fibers are spun into silk yarn. Spun silk yarn is used for the filling in some silk, woolen, and cotton fabrics.

History

Discovery of silk. No one knows for sure when silk was discovered. According to a Chinese legend, it was discovered about 2700 B.C. in the garden of Emperor Huangdi. The emperor ordered his wife, Xilingshi, to find out what was damaging his mulberry trees.

Xilingshi found white worms eating the mulberry leaves and spinning shiny cocoons. She accidentally dropped a cocoon into hot water. As she played with the cocoon in the water, a delicate, cobwebby tangle separated itself from the cocoon. Xilingshi drew it out and found that one slender thread was unwinding itself from the cocoon. She had discovered silk.

Xilingshi persuaded her husband to give her a grove of mulberry trees, where she could grow thousands of worms that spun such beautiful cocoons. It is said that Xilingshi invented the silk reel, which joined these fine filaments into a thread thick and strong enough for weaving. Some stories also credit her with inventing the first silk loom.

No one knows how much, if any, of this story is true. But historians do know that silk was first used in China. The Chinese guarded the secret of the silkworm. Disgrace and death faced the traitor who disclosed the origin of silk to the outside world. Only the Chinese knew how to make silk for about 3,000 years.

Silk making spreads. China carried on a profitable silk trade with Western nations in the days of the Han Dynasty (founded in 202 B.C.). Traders from ancient Persia (now Iran) bought richly colored silks from Chinese merchants. Camel caravans blazed routes across Asia, transporting silk from China to Damascus, the market place at which East and West met. From Damascus, silk was taken to the Roman Empire, where there were riches to exchange for it.

As early as the 300's B.C., the Western world heard rumors of the strange worm that spun silk threads. But no one in the West saw the worm until about A.D. 550. At that time, Persia controlled all silk that came out of China. Persians sold it at fabulously high prices.

The Roman, or Byzantine, emperor Justinian I objected to paying high prices to the Persians. In about 550, he tried unsuccessfully to find a trade route from Constantinople (now Istanbul) to China that would bypass Persia. He later sent two monks to China as spies. Risking death, the monks smuggled out silkworm eggs and mulberry seeds in hollow bamboo canes. This adventure ended the Chinese and Persian silk monopolies.

During the next few hundred years, various peoples

learned how to raise silkworms and take silk from the cocoons. The Muslims brought silkworms to Spain and Sicily in the 800's and 900's. By the 1200's, Italy had become the silk center of the West. Silk weaving began in France in the 1500's. The French soon rivaled the Italians as silk manufacturers. Silk weaving became an important industry in England after many skilled Flemish weavers entered the country in the late 1500's. The first U.S. silk factory was built in Mansfield, Connecticut, in 1810.

Silk making today. Before World War II (1939-1945), the hosiery industry was the biggest user of raw silk. Now most stockings are made of nylon. There once was also a demand for silk lingerie and silk ribbons. Today these products are usually made of synthetic fibers (see Synthetics). Most silk is used in making clothing, curtains, and upholstery. It has also been used with other natural and synthetic fibers to achieve new effects in fabrics. For such fabrics, the Federal Trade Commission requires that the exact fiber composition be stated on a label attached to the fabric. John M. Sullivan, Jr.

See also **Cocoon; Moth; Mulberry.**

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Silk Road was a group of ancient trade routes connecting China and Europe. The Silk Road flourished primarily from the 100's B.C. to the A.D. 1500's. The routes stretched across about 5,000 miles (8,050 kilometers) of mountains and deserts in central Asia and the Middle East between eastern China and the Mediterranean Sea.

The Silk Road got its name from the vast amount of Chinese silk carried along it. The Chinese were the first to learn to make silk, and they guarded the secret. China was the only supplier of silk until the A.D. 500's, when Western countries discovered how to make the fabric.

The cities along the Silk Road provided food, water, and rest for travelers, as well as goods for trade. Of these cities, Khotan (now Hotan, China) was famous for its jade. The region of Fergana in present-day Uzbekistan was known for its powerful horses.

Camel caravans carried most goods across the dry, harsh regions along the Silk Road. By A.D. 800, traffic began to decrease as traders started to travel by safer sea routes. A final period of heavy use occurred during the 1200's and 1300's, when the Mongols ruled central Asia and China. Richard L. Davis

See also **Kushan Empire; Lanzhou.**

WORLD BOOK map

The Silk Road was a group of trade routes between China and Europe that flourished from the 100's B.C. to the A.D. 1500's.

Silk-screen printing. See Screen printing.

Silkworm. See Silk.

Silky oak is a fast-growing, attractive tree that grows in dry subtropical forests of New South Wales and Queensland, Australia. It reaches a height of 130 feet (40 meters), has deeply divided fernlike leaves, and bears masses of yellow-orange flowers on long flower spikes. Silky oak has an attractively colored timber that is yellow-brown with dark markings. The timber is used to make furniture.

Scientific classification. Silky oak belongs to the protea family, Proteaceae. It is *Grevillea robusta.*

WORLD BOOK photo by E. F. Hoppe

The silky terrier

Silky terrier is a small dog developed about 1900 in Australia. It is descended primarily from crosses between Australian and Yorkshire terriers. The dogs were once used on Australian farms to control rodents. Silky terriers have erect ears and long, silky, smoky-blue coats with tan markings. Their tails generally are *docked* (cut short). The dogs weigh about 10 pounds (4.5 kilograms).

Critically reviewed by the Silky Terrier Club of America

Silliman, Benjamin (1779-1864), a leading American educator and scientist, founded the *American Journal of Science* in 1818. The journal at first published articles by scientists of many fields. Today, it contains only articles about geology.

Silliman was born in North Stratford (now Trumbull), Connecticut. He graduated from Yale University. In 1802, he became Yale's first professor of chemistry and natural history. He was best known for his research into the chemical composition of a meteorite that fell to the earth in 1807. His research helped prove that meteorites are made of materials that exist on the earth. The mineral *sillimanite* was named after Silliman. M. Norton Wise

Sillimanite, *SIHL uh muh nyt,* is a mineral that is brown, pale green, or white, and has a glassy luster. It

belongs to the large class of minerals known as silicates (see Silicate). Its chemical formula is Al_2SiO_5. Sillimanite is sometimes called *fibrolite* because its crystals commonly are fiberlike. It is found in Brazil, central Europe, Myanmar, Sri Lanka, and the United States. It occurs in *metamorphic rock* (rock changed by heat or by heat and pressure). See Metamorphic rock. David F. Hess

Sillitoe, Alan (1928-), is a British author known for his realistic fiction about working-class life in English industrial towns. Many of his leading characters are angry young men rebelling against their dreary lives.

Sillitoe gained fame for his first novel, *Saturday Night and Sunday Morning* (1958), and his long story "The Loneliness of the Long Distance Runner" (1959). Both works were adapted into influential motion pictures, with Sillitoe writing the screenplays.

Sillitoe's other novels include *A Tree on Fire* (1967), *A Start in Life* (1970), *Life Goes On* (1985), *Leonard's War* (1991), and *The Broken Chariot* (1998). Sillitoe has also written many poems and short stories as well as stories for children and plays.

Sillitoe was born March 4, 1928, in Nottingham, England, into a working-class family. He quit school at age 14. His experiences working in a bicycle factory inspired *Saturday Night and Sunday Morning*. Michael Seidel

Sills, Beverly (1929-), an American singer, became one of the most popular operatic sopranos of the 1960's and 1970's. She won fame for her flexible voice, her wide range, and her versatility and charm. Sills became noted for her performances of works by such diverse composers as Gaetano Donizetti, George Frideric Handel, and Giuseppe Verdi. She also earned recognition as a fine actress in such roles as Cleopatra in Handel's *Julius Caesar* and as Violetta in Verdi's *La Traviata*.

Beverly Sills's real name is Belle Silverman. She was born May 25, 1929, in New York City and received her training there. Sills made her operatic debut in 1946 and joined the New York City Opera in 1955. She sang with leading European opera companies. She made her Metropolitan Opera debut in 1975 in Gioacchino Rossini's *The Siege of Corinth*. Sills retired as a performer in 1980.

Sills has been active in arts administration. She was general manager of the New York City Opera from 1979 to 1989. She became a managing director of the Metropolitan Opera in 1991 and served as chairwoman of the Lincoln Center for the Performing Arts from 1994 to 2002. Sills wrote two autobiographies, *Bubbles: A Self-Portrait* (1976) and *Beverly* (1987). Martin Bernheimer

Silo is a storage bin for chopped plants and grains. Silos on farms allow farmers to supply livestock with nutritious feed all year and to delay the sale of crops. Silos are also used at grain-handling terminals, where trucks, trains, and ships are filled with grain for shipment.

Farmers store hay, corn, grain, juicy grasses called *sorghums*, and other high-moisture crop products in silos. Machines are used to chop up the plants and to blow the plant materials, called *silage*, in at the top of the silo. Silos are unloaded from the bottom. If silage is packed properly, all air is forced out. Feed and grains do not spoil, because molds that cause spoilage cannot survive without air. Chemical changes called *fermentation* occur in the silage and also help prevent rotting. Acids produced by fermentation help to prevent the growth of molds. If a feed does not have enough starch or sugar for fermentation, farmers may add certain types of acids to keep it from spoiling.

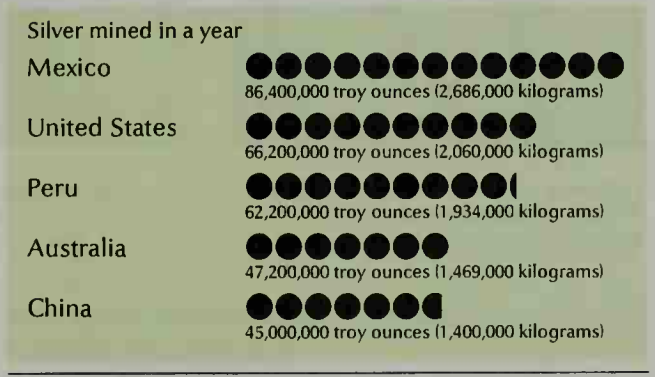
Americans learned how to make silos from Europeans in the 1870's. The first silos were pits covered with boards. Then Fred L. Hatch, an Illinois farmer, built a square, wooden silo above ground in 1873. But its corners made it impossible to pack the feed tightly. In 1882, Franklin H. King, an agricultural scientist in Wisconsin, built a round silo. Round silos resist the pressure of tightly packed feed best. Today, round silos made of stone, brick, clay tile, sheet metal, concrete, or wood blocks are used worldwide. Airtight, fiberglass-lined steel silos are used where farmers use silage all year. Silage is also stored in trenches and in aboveground bunkers and boxes. Martin L. Hellickson

Silt is a fine-grained or muddy material made up of tiny particles of rock that settle at the bottom of rivers and other bodies of water. A material which sinks in water or air is known as *sediment*. Common examples of sediment are clay, silt, sand, soil, and gravel. Silt is made up of particles ranging from 0.004 to 0.0625 millimeter ($\frac{1}{6,500}$ to $\frac{1}{400}$ inch) in diameter. Most lands with silt deposits are fertile. Taylor J. Johnston

Silver is a soft, white metal. It was one of the first metals used by human beings. People have used silver for ornaments and for money since about 4000 B.C. Many beautiful objects, including jewelry, fine tableware, religious decorations, coins, and mirrors, are made of silver. Silver also plays an important role in dentistry, medicine, photography, and electronics.

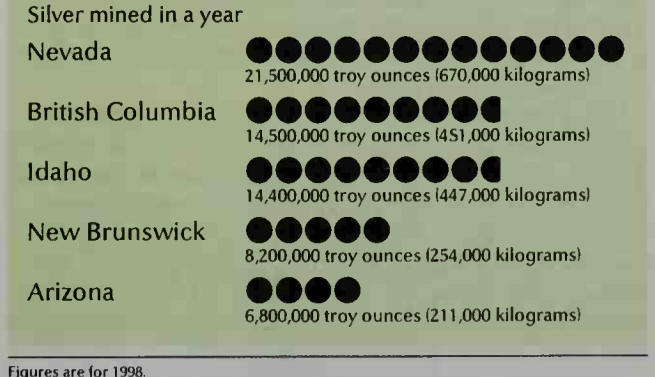
Most countries of the world have deposits of silver

Leading silver-mining countries



Figures are for 1998.
Source: U.S. Geological Survey.

Leading silver-mining states and provinces



Figures are for 1998.
Sources: U.S. Geological Survey; Statistics Canada.

How silver flatware is made

The production of a piece of high-quality silverware involves many steps. The process begins with an artist's design. Working from the design, a craftworker makes a steel tool called a *die,* which forms sheets of metal into desired shapes. The shapes are then trimmed, buffed to remove any roughness, and polished repeatedly to bring out the metal's natural luster. These pictures show some of the steps involved in making a piece of silver flatware.

A model is created by carving a design from a sketch into clay or plaster. It will serve as the pattern for the die.

A steel die for every piece is carved by hand. A blank piece of silver is pressed into the die to imprint the design.

Trimming removes excess silver from around the edges of the piece. They are then smoothed on an abrasive belt.

Polishing rubs out small imperfections. The piece is held against a rotating wheel and polished with oil and pumice.

Cosmetic treatment involves rubbing the piece with a powder called *rouge* to bring out shimmering highlights.

Reed & Barton Silversmiths

Final inspection ensures that the finished piece is free from flaws. Then the piece is weighed and sealed in plastic.

and silver ore. However, mining silver is expensive, and it can be recovered economically in only a few places.

Silver in its pure form is called *metallic, free,* or *native.* Pure silver is extremely soft. As a result, a small amount of another metal—usually copper—is generally added to increase the silver's hardness and strength. For example, *sterling silver* is an *alloy* (mixture) of 92.5 percent silver and 7.5 percent copper. *Silver plate* is an object made of a base metal, such as steel, that is coated with a thin layer of silver or silver alloy.

Uses of silver. Silver, along with copper and gold, is called a *coinage metal.* It has been used to make coins for thousands of years. In the past, the United States had silver coins that contained 90 percent silver and 10 percent copper. But in 1965 and 1970, Congress passed laws to eliminate silver from new dimes, quarters, half dollars, and dollars. The U.S. Mint uses a high silver content to make some commemorative coins for collectors and some bullion coins for investors.

Silversmiths craft many art objects from silver. The metal is also used by the electrical and electronic industry for wire and other items, because silver conducts electric current well. Doctors use thin plates, wires, and drainage tubes made of silver during surgery, because silver helps kill bacteria. Dentists fill cavities with silver *amalgam*—a mixture of silver, tin, and mercury.

Silver compounds also have many uses. Compounds of silver include silver nitrate, silver bromide, and several silver oxides. Silver nitrate is one of the few water-soluble silver compounds, and is used to make silver plate and silver mirrors. Silver bromide plays an important role as the light-sensitive chemical in photographic film (see **Photography** [Exposing the film]). Manufacturers of batteries use silver oxides to make small, powerful batteries used in calculators, hearing aids, and watches.

Properties of silver. Silver has an atomic number of 47 and an atomic weight of 107.8682. Its atomic symbol, Ag, comes from the Latin word for silver, *argentum.* Silver melts at 961 °C and boils at 2193 °C. At 20 °C, it has a

density of about 10.49 grams per cubic centimeter (see Density).

Silver reflects 95 percent of the light that strikes it, making it the most *lustrous* (shiny) of the metals. Silver conducts heat and electric current better than any other metal does. It is second only to gold in *ductility* (the ability to be drawn out into fine wires) and *malleability* (the ability to be hammered into various shapes).

Silver, like gold, does not react chemically with most substances. However, the presence of sulfur compounds causes silver to develop a black or gray coating of silver sulfide called *tarnish*. Because polluted air contains these compounds, silver tarnishing is a greater problem today than in the past.

Sources of silver. Mexico leads the world in the production of silver, followed by the United States and Peru. The main silver-producing states of the United States include Nevada, Idaho, and Arizona. The leading silver-mining provinces of Canada are British Columbia and New Brunswick.

Silver occurs in deposits of native metal and as silver ores. Native silver mines provide only a small amount of the world's silver. The most common silver ores contain the mineral argentite or the compound silver sulfide. Silver often occurs along with such metals as copper, gold, lead, and zinc. Miners obtain about 80 percent of the world's silver as a by-product of mining and processing these metals.

Extracting and refining silver. There are several methods of extracting silver from ores. Most of the world's silver is extracted from copper and lead ores. These ores are first crushed and then smelted, producing a mixture that contains the primary metal and small quantities of silver. In the process of refining copper, the silver is separated from the copper to form a mixture called *sludge*. The sludge is removed and treated with nitric acid to dissolve the silver. The silver is then recovered by *electroplating* (see Electroplating).

Silver is extracted from metallic lead ore by the *Parkes process*. In this process, zinc is added to *molten* (melted) lead ore to form a solid alloy with the silver contained in the ore. This alloy, which is less dense than molten lead, floats to the surface and is raked off. Heating the alloy then removes the zinc from the silver.

Once extracted, silver is removed from the extracting solution. A process called *electrolysis* is then used to refine and purify the extracted silver. During electrolysis, the impure silver serves as the *anode* (positive electrode), and a strip of pure silver metal serves as the *cathode* (negative electrode). Refiners dip the two electrodes into a solution of silver nitrate and nitric acid. An electric current sent between the electrodes causes the anode, or impure silver, to dissolve. The impurities in the silver fall to the bottom of the solution, and pure silver crystals collect on the cathode. These crystals are scraped off, melted, and cast into bars of silver. See Electrolysis.

Raymond E. Davis

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Coin collecting (Collecting United States coins)
Colonial life in America (Gold, silver, and pewter)
Dollar
Free silver
Metallurgy
Money
Silver nitrate
Western frontier life in America (The search for gold and silver)

Additional resources

Fisher, Leonard E. *The Silversmiths.* 1964. Reprint. Benchmark Bks., 1997. Younger readers.
Glanville, Philippa. *Silver: History & Design.* Abrams, 1997.
Smith, Keith. *Silversmithing.* Crowood, 2000.

Silver nitrate, *NY trayt,* is a chemical used in medicine and industry. It burns the skin and can cause severe poisoning or even death if swallowed. Doctors use silver nitrate to *cauterize* (burn) wounds to prevent bleeding or infection, and to remove warts. They use a mild solution of it to treat certain eye and skin diseases, and as an antiseptic. In the United States, some states require that the eyes of newborn infants be treated with silver nitrate solution to prevent possible blindness.

The photographic industry uses silver nitrate in making film. Most silver salts used in film are manufactured from silver nitrate. For example, silver bromide photographic film is made from silver nitrate and a potassium bromide solution. Gelatin, a protein substance, is then added to the solution to form a substance called an *emulsion* that coats the film (see Photography [Exposing the film]). Silver nitrate is also used to make mirrors and indelible ink, and in silver plating.

Silver can be purified by dissolving it in nitric acid and passing electric current through the silver nitrate solution. Pure silver forms at the *cathode* (negative electrode). Chemists use silver nitrate to help prepare other silver compounds and to identify chemicals in solution.

Manufacturers make silver nitrate by dissolving silver in nitric acid and then evaporating the solution. They sometimes melt silver nitrate and allow it to harden into a crystalline mass. Silver nitrate in this form is also known as *lunar caustic*.

Silver nitrate has the chemical formula $AgNO_3$. It dissolves easily in water. Patrice C. Bélanger

Silverbell is any of a group of trees or shrubs with bell-shaped flowers. These flowers have four petals that grow from the base and are normally white in color. Silverbells possess pointed leaves with *serrated* (toothed) edges. Their dark brown fruits have winglike structures and contain one to three seeds.

Silverbells are native to eastern North America and eastern Asia. A well-known North American species, the *Carolina silverbell,* ranges from West Virginia to northern Florida. The Carolina silverbell usually grows no more than 40 feet (12 meters) tall and generally occurs in lower elevations. However, a variety of silverbell can reach a height of 90 feet (27 meters), taller than any other variety. It lives in mountainous areas and is commonly called the *mountain silverbell.* Some mountain silverbells can produce beautiful pink flowers. The only Asian species of silverbell, the *Chinese silverbell,* grows in eastern China and may reach 75 feet (23 meters) in height.

People throughout Europe and the northeastern and midwestern United States plant silverbells in gardens. The larger trees also yield valuable timber.

Scientific classification. Silverbells belong to the storax family, Styracaceae. The scientific name of the Carolina silverbell is *Halesia tetraptera,* and the mountain silverbell is *H. tetraptera,* variety *monticola.* The Chinese silverbell is *H. macgregorii.*

Silverfish is a small, wingless insect found in cool, damp places. It is a common household pest. The silverfish is gray or silver in color. It has two long antennae

and three thin, bristlelike tail parts. It feeds on such starchy materials as books, wallpaper, and clothing.

James E. Lloyd

Scientific classification. The silverfish belongs to the firebrat and silverfish family, Lepismatidae. Its scientific name is *Lepisma saccharina.*

See also Insect (picture: Familiar kinds of insects).

Silverstein, *SIHL vuhr STYN* or *SIHL vuhr STEEN,* **Shel** (1932-1999), was a popular American author and illustrator of poetry for children. Silverstein was also a successful cartoonist and songwriter who wrote novelty and country songs and also wrote several plays.

Silverstein wrote and illustrated three collections of poetry that rank among the most popular in the history of children's literature. They are *Where the Sidewalk Ends* (1974), *A Light in the Attic* (1981), and *Falling Up* (1996). His poems range from serious to wacky, and many reflect clever word play and slightly off-color or bizarre humor.

Silverstein's most successful book, *The Giving Tree* (1964), has become a children's classic. It is a parable about loving that tells about a tree that gives its fruit, branches, and finally its trunk to make a man happy. Silverstein's other works for children include *Lafcadio, The Lion Who Shot Back* (1963), *The Missing Piece* (1976), and *The Missing Piece Meets the Big O* (1981). The last two books, illustrated with simple geometric shapes, are tales about the search for freedom and independence.

Shelby Silverstein was born on Sept. 25, 1932, in Chicago. In 1956, he began a long career as a cartoonist for *Playboy* magazine. He composed a number of songs, including "A Boy Named Sue" (1969), which became a hit for country singer Johnny Cash. Ann D. Carlson

Simcoe, *SIHM koh,* **John Graves** (1752-1806), was a British soldier and the first lieutenant governor of Upper Canada. He served in this position from 1791 to 1797. During the Revolutionary War in America (1775-1783), Simcoe raised and commanded a corps of loyalists called the Queen's Rangers. As lieutenant governor of Upper Canada, he helped found Toronto. Simcoe was born on Feb. 25, 1752, in Cotterstock, England.

See also Toronto (History).

Simenon, *seem NAWN,* **Georges,** *zhawrzh* (1903-1989), a Belgian-born author, created the fictional detective Jules Maigret, an inspector with the Paris police. Simenon, who wrote in French, wrote about 80 novels and short-story collections that deal with Maigret.

In most Maigret stories, Simenon emphasized the motives behind a crime more than the crime itself. Instead of step-by-step detection of the criminal, Maigret solves crimes using patience and insight into human nature. Simenon also concentrated on creating realistic characters. He became noted for his vivid descriptions of the people, sights, and sounds of Paris and the small towns of France.

Georges Joseph Simenon was born on Feb. 13, 1903, in Liège, Belgium. He became a newspaper reporter at the age of 15 and published his first novel in 1921. *Maigret and the Enigmatic Lett* (1931) was the first Maigret story to be published. Simenon also wrote over 300 other novels and short stories, many of them psychological thrillers, under his own name and 18 other names. After retiring from writing fiction at the age of 70, he produced several volumes of memoirs. David Geherin

Simhat Torah, *sihm KHAHT toh RAH,* is a Jewish festival of rejoicing in the Torah, or Law. Simhat Torah marks the end of the annual cycle of readings from the Torah that take place in the synagogue every Saturday morning. The cycle begins again on the first Saturday after Simhat Torah. The festival falls on the 23rd day of the Hebrew month of Tishri. Tishri usually occurs in September and October. Jews in Israel and Reform Jews observe the festival on the 22nd day of Tishri. See also Bible (The Bible in worship); Sukkot. B. Barry Levy

Simile, *SIHM uh lee,* is a figure of speech used in describing or explaining something. It points out a likeness between two different objects or ideas by using a connective word. This connective word is usually *like* or *as.* An example of a simile would be, "He is as cross *as* a bear today," or "She ran *like* a deer."

Often a simile becomes so compact that we drop the connecting word. Then the simile becomes a *metaphor.* For example, the simile "He is *like* a fox" becomes a metaphor in "He *is* a fox." Paul B. Diehl

See also Figure of speech; Metaphor.

Simon, *SY muhn,* **Herbert Alexander** (1916-2001), was an American scientist known for his work in economics, psychology, and computer science. He won the 1978 Nobel Prize in economics for his research on the decision-making process in business.

Simon cast doubt on the traditional theory of business decision making. This theory holds that business executives always choose the alternative that will bring the most profits. Simon maintained that executives, who have limited time and information to make decisions, settle for what they consider reasonable gains.

Simon also used computers to study human thought processes. His research involved the development of computer programs that duplicate human reasoning and problem solving.

Simon was born on June 15, 1916, in Milwaukee. He taught at the Illinois Institute of Technology from 1942 to 1949, when he joined the faculty of Carnegie Mellon University. His books include *The Sciences of the Artificial* (1969), *Human Problem Solving* (1972), and *Models of Discovery* (1977). Barry W. Poulson

Simon, *SY muhn,* **Neil** (1927-), is an American playwright. His almost unbroken succession of hit comedies and musicals has made him the most commercially successful playwright in American theater history. Simon won the 1991 Pulitzer Prize for drama for his comedy-drama *Lost in Yonkers* (1990).

Marvin Neil Simon was born on July 4, 1927, in New York City. His first plays were light, joke-filled comedies, beginning with *Come Blow Your Horn* (1961). He based *Barefoot in the Park* (1963) on his experiences as a newlywed in a Manhattan walk-up apartment. In *The Odd Couple* (1965), Simon explored more serious themes about personal relationships. This play concerns two men separated from their wives. The men set up housekeeping together but repeat the mistakes that wrecked their marriages.

Last of the Red Hot Lovers (1969) tells the adventures of a middle-aged husband who thinks society is experiencing a sexual revolution that has passed him by. *The Gingerbread Lady* (1970) describes the personal problems of an aging, alcoholic ex-singer. In *The Prisoner of Second Avenue* (1971), a married couple tries to cope

with the problems of living in a large U.S. city. *Plaza Suite* (1968), *California Suite* (1976), and *London Suite* (1995) are collections of comic one-act plays. *Rumors* (1988) and *The Dinner Party* (2000) are farces that examine marital relationships.

Chapter Two (1977) is a partly autobiographical comedy-drama about a writer who remarries after the death of his first wife. *Brighton Beach Memoirs* (1983), *Biloxi Blues* (1985), and *Broadway Bound* (1986) are autobiographical dramas about the playwright's experiences as an adolescent and a young man. *Laughter on the 23rd Floor* (1993), another autobiographical work, tells the story of a group of writers working on a popular television show. *Jake's Women* (1992) explores relationships between a writer and various women. *45 Seconds from Broadway* (2001) is a comedy about actors and playwrights who gather at a popular Broadway coffee shop in New York City.

Simon wrote the stories for four musical comedies—*Little Me* (1962), *Sweet Charity* (1966), *Promises, Promises* (1968), and *They're Playing Our Song* (1979). He also wrote the music for the Broadway show *The Capeman* (1998). Simon adapted several of his plays for motion pictures. He also wrote original scripts for such films as *The Out-of-Towners* (1970), *The Heartbreak Kid* (1972), *Murder by Death* (1976), and *The Goodbye Girl* (1977). Simon's two-volume autobiography includes *Rewrites* (1996) and *The Play Goes On* (1999). Mardi Valgemae

Simon, Paul (1941-), is an American singer, songwriter, and guitarist. He teamed with his childhood friend Art Garfunkel to form one of the most popular folk-rock groups of the 1960's, and he began a successful solo career in the 1970's.

Simon and Garfunkel first billed themselves as Tom and Jerry, and in 1957 recorded a minor hit titled "Hey, Schoolgirl" while they were still in high school. Simon and Garfunkel made their popular breakthrough in 1965 with the success of the folk-rock version of their song "The Sounds of Silence." Simon wrote almost all their material, including the hits "Mrs. Robinson" (1968) and "Bridge Over Troubled Water" (1970).

Simon and Garfunkel separated in 1970. Simon's major solo success of the 1970's was the album *Still Crazy After All These Years* (1975). Simon reunited with Garfunkel in 1981 for a concert in New York City's Central Park. It was recorded as an album and inspired a reunion tour. In 1986, Simon released the acclaimed album *Graceland,* which he made with black South African musicians. In the 1990's, he turned to Brazilian music for inspiration. Simon was born on Oct. 13, 1941, in Newark, New Jersey. Don McLeese

Simon, Saint, was one of Jesus Christ's 12 apostles. His name appears only in the four lists of the 12 apostles in the New Testament. Simon is called *Zelotes,* a Greek word meaning *The Zealot,* in Luke 6:15 and Acts 1:13. In Matthew 10:4 and Mark 3:18, he is called *the Cananaean,* probably the Aramaic equivalent of *Zealot.* This title indicates he may have been associated with radical Jewish revolutionaries known as the Zealots. According to later tradition, Simon preached the Gospel in Egypt. He then traveled with Saint Jude to preach in Persia, where both were said to have been martyred. Simon's feast day in the Roman Catholic Church is October 28. The Eastern Orthodox Churches celebrate Simon's feast day on May 10. See also Apostles. Richard A. Edwards

Simon, *SY muhn,* **William Edward** (1927-2000), served as secretary of the treasury of the United States from 1974 to 1977. President Richard M. Nixon had appointed Simon deputy secretary of the treasury in 1972. In 1973, Nixon named him administrator of the Federal Energy Office (FEO). Simon held both offices until confirmed by the Senate as secretary of the treasury in May 1974. In September 1974, President Gerald R. Ford appointed him to an additional post, chairman of the Economic Policy Board. In that role, Simon served as Ford's chief adviser on economic policy.

Simon was born on Nov. 27, 1927, in Paterson, New Jersey. He graduated from Lafayette College in 1951 and joined a New York City brokerage firm in 1952. Guy Halverson

Simon Peter. See Peter, Saint.

Simone Martini, *see MOH nay mahr TEE nee* (about 1285-1344), was an Italian painter. He was born in Siena, a leading art center of the 1300's. Simone's colorful, decorative, yet realistic style ranks as the outstanding example of the Sienese school of painting.

In 1315, Simone painted *The Virgin in Majesty,* a *fresco* (painting on damp plaster) in the Siena city hall. This fresco honors the Virgin Mary, the patron saint of Siena. Perhaps Simone's greatest work is the *Annunciation* (1333), a dramatic, richly colored altarpiece painted for the Siena cathedral. From about 1340 until his death, Simone worked in Avignon, France, the home of the popes at that time. He painted many works for the Palace of the Popes there. These paintings helped shape the naturalistic style of such Flemish masters as Robert Campin and Jan van Eyck. Samuel Y. Edgerton, Jr.

See also Jesus Christ (picture).

Simplon Pass and Tunnel, *SIHM plahn,* are important gateways through the Swiss Alps (see Switzerland [political map]). Napoleon built a military road over the pass in the early 1800's. The road begins at Brig in the Rhône Valley. It reaches an elevation of 6,592 feet (2,009 meters), then descends toward the Lake District of northern Italy. The Simplon Tunnel is one of the longest railroad tunnels in the world. It is 12.3 miles (19.8 kilometers) long, and has a maximum elevation of 2,312 feet (705 meters). It consists of two parallel tunnels. One tunnel was completed in 1906, and the other was completed in 1922. Herbert H. Einstein

Simpson, Alan Kooi (1931-), a Wyoming Republican, was elected to the United States Senate in 1978 and reelected in 1984 and 1990. He did not run for reelection in 1996. Simpson served as Senate majority *whip* (assistant leader) from 1984 to 1987 and minority whip from 1987 to 1995.

Simpson became prominent as coauthor of the proposed Simpson-Mazzoli bill, which called for major reform in U.S. immigration law. The bill was named after Simpson and Representative Romano L. Mazzoli of Kentucky, a Democrat. Congress blocked the bill in 1984, but it passed a revised version in 1986. The law offered amnesty to several million aliens who had been living illegally in the United States since before 1982.

Simpson was born on Sept. 2, 1931, in Denver, Colorado. He received a bachelor's degree in 1954 and a law degree in 1958 from the University of Wyoming. In 1959, he became assistant attorney general of Wyoming.

From 1964 to 1977, Simpson served in the Wyoming House of Representatives. Guy Halverson

Simpson, Sir George (1787?-1860), served as governor of the North American territories of the Hudson's Bay Company from 1826 to 1860. His leadership helped make the company one of the world's greatest fur-trading firms.

During most of Simpson's term, the company's land included a large part of what are now Canada and the Pacific Northwest region of the United States. Simpson ranked as the company's top governing official and became known for his firm rule. He established trading posts on the Pacific coast, developed friendly relations with the Indians, and provided assistance to Arctic expeditions.

Simpson was born in Loch Broom, in what is now the Highland Region of Scotland. He settled in Canada after joining the Hudson's Bay Company in 1820. Simpson played an important part in uniting the Hudson's Bay Company with its rival, the North West Company, in 1821. Later that year, he became governor of the company's northern territories. Simpson often made difficult journeys to inspect trading posts and forts. He was knighted in 1841. P. B. Waite

See also **Hudson's Bay Company; North West Company.**

Simpson, O. J. (1947-), ranks as one of the greatest running backs in football history. He was noted for his speed and his ability to dodge tacklers. Simpson rushed for 11,236 yards during his 11-year professional career with the Buffalo Bills and the San Francisco 49ers. He led the National Football League (NFL) in rushing in 1972, 1973, 1975, and 1976. In 1973, Simpson set an NFL record for most yards gained in a season—2,003. That record was broken in 1984 by Eric Dickerson of the Los Angeles Rams. In 1976, Simpson rushed for a record 273 yards in a single game. Walter Payton of the Chicago Bears broke that record in 1977.

Buffalo Bills

O. J. Simpson

Orenthal James Simpson was born on July 9, 1947, in San Francisco. He earned All-America honors playing at the University of Southern California in 1967 and 1968. Also in 1968, Simpson won the Heisman Trophy as the nation's top college football player. He played for Buffalo from 1969 until 1978, when he was traded to San Francisco. Simpson retired the following year and became a television sports commentator and an actor.

In 1994, Simpson was arrested and charged with the murders of his ex-wife, Nicole Brown Simpson, and her friend Ronald Goldman. He pleaded not guilty and was placed on trial by the state of California later that year. The televised trial received an enormous amount of publicity. In 1995, the jury found Simpson not guilty of the charges against him. But in a civil trial in 1997, a jury found Simpson responsible for the wrongful deaths of Ronald Goldman and Nicole Brown Simpson and ordered that he pay their families $33.5 million in damages. Carlton Stowers

Simpson, Wallis Warfield. See **Edward VIII.**

Sinai. See **Mount Sinai.**

Sinai Peninsula, *SY ny,* is the part of Egypt that lies east of the Suez Canal and the Gulf of Suez, and borders western Israel. It covers about 23,400 square miles (60,700 square kilometers) in southwestern Asia and has about 300,000 people (see **Egypt** [terrain map]).

The Sinai Peninsula is a dry land with a few small oases. It has a sandy coastal plain in the north, a high limestone plateau in its center, and mountains in the south. The area has deposits of petroleum, manganese, and other minerals.

The western part of Egypt and the Sinai Peninsula were first linked together as a province of the Islamic Empire in the A.D. 600's. In 1906, an agreement between the United Kingdom and the Ottoman Empire gave Egypt control over the peninsula. Israeli troops occupied the Sinai during the 1967 Arab-Israeli war. The Israelis completely withdrew from the Sinai Peninsula by 1982. However, a border dispute at Taba on the Gulf of Aqaba continued until 1989. Malcolm C. Peck

See also **Egypt** (History); **Israel** (History [maps]).

Sinatra, Frank (1915-1998), ranks among the most famous singers in the history of popular music. Nicknamed "The Voice," he became well known for both his soulful ballad singing and his interpretations of rhythm songs. He made his motion-picture debut in 1941 and appeared in over 50 films. He won the 1953 Academy Award as best male supporting actor for his work in *From Here to Eternity.*

© Jim Britt, Shooting Star

Frank Sinatra

Francis Albert Sinatra was born on Dec. 12, 1915, in Hoboken, New Jersey, the son of a firefighter. He sang with local bands and won an amateur show prize in 1937 before joining trumpeter Harry James's band in 1939. While touring with the band of trombonist Tommy Dorsey from 1940 to 1942, he gained great popularity with teen-agers throughout the United States. Sinatra began his career as a solo singer in 1943 and later gained popularity with audiences of all ages. Paul F. Wells

Sinclair, Upton (1878-1968), was an American writer and reformer. Sinclair was an idealistic supporter of socialism and became famous as a *muckraker.* The muckrakers were writers in the early 1900's whose principal goal was exposing social and political evils.

Sinclair's work is uneven in quality, yet he is one of the most translated American authors. The impact of his fiction on American political history is perhaps greater than that of any other American novelist except Harriet Beecher Stowe, who wrote *Uncle Tom's Cabin.* Sinclair's best-known novel, *The Jungle* (1906), is a powerful naturalistic exposure of the wretched sanitary and work conditions in the meat-packing industry. *The Jungle* led to the passage of America's first pure food laws. In other

novels, he attacked capitalistic society *(The Metropolis* and *The Moneychangers,* both 1908), conditions in coal mines *(King Coal,* 1917), and the oil industry *(Oil!,* 1927).

Sinclair also wrote several nonfiction books exposing what he saw as the corruption that capitalism created in various areas of American life. For example, *The Brass Check* (1920) deals with journalism, and *The Goose-Step* (1923) with higher education.

From 1940 to 1953, Sinclair published the Lanny Budd series of 11 novels, named for the main character. The novels span American and world history from 1913 to 1949. The best-known novel in the Lanny Budd series, *Dragon's Teeth* (1942), received the 1943 Pulitzer Prize for fiction.

Sinclair helped organize the American Civil Liberties Union and the League for Industrial Democracy. He ran unsuccessfully three times each for Congress and for governor of California. Upton Beall Sinclair was born in Baltimore. Daniel Mark Fogel

Additional resources

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Sinew. See **Tendon**.

Sing Sing is the name of a state prison in Ossining, New York. From 1970 to 1983, it was called Ossining Correctional Facility. The prison has its own school and factories. Sing Sing originally had a building for women. But the facility now has no women prisoners. Construction of Sing Sing began in 1825 with convict labor. Later, new buildings were put up. Critically reviewed by the New York State Department of Correctional Services

Singapore is a small island country in Southeast Asia. It lies near the southern tip of the Malay Peninsula about where the South China Sea and the Indian Ocean meet. The sea is an arm of the Pacific Ocean. Singapore consists of a large island and more than 50 smaller islands. The large island, which is also called Singapore, covers 221 square miles (572 square kilometers). The other islands have a combined area of about 18 square miles (46 square kilometers). About half are uninhabited.

Facts in brief

Capital: Singapore.
Official languages: Chinese, English, Malay, and Tamil.
Official name: Republic of Singapore.
Total land area: 239 mi² (618 km²). *Greatest distances* (on Singapore island)—east-west, 26 mi (42 km); north-south, 14 mi (23 km). *Total coastline*—32 mi (51 km).
Elevation: *Highest*—Timah Hill, 581 ft (177 m) above sea level. *Lowest*—sea level.
Population: *Estimated 2002 population*—3,641,000; population density, 15,234 per mi² (5,892 per km²); distribution, 100 percent urban. *1990 census*—2,705,115.
Chief products: *Manufacturing and processing*—chemicals, electronic equipment, lumber, machinery, metals, paper, petroleum products, processed food, rubber, ships, textiles and clothing, transportation equipment. *Agriculture*—eggs, pork, poultry.
National anthem: "Majulah Singapura" ("Onward Singapore").
Flag: There are two horizontal stripes, red on top (for equality and brotherhood) and white below (for purity and virtue). A white crescent and five white stars (for democracy, peace, progress, justice, and equality) lie in the upper left corner. See **Flag** (picture: Flags of Asia and the Pacific).
Money: *Basic unit*—Singapore dollar.

The majority of Singapore's people are Chinese. Malays make up the largest minority group. Almost all the people live in the capital, which is also named Singapore. The capital lies on the main island's southern coast and is a crowded, bustling center of trade, finance, and manufacturing. The city's economic activity helps make Singapore one of Asia's most prosperous countries.

Government. Singapore is a republic. An 81-member, one-house Parliament makes the country's

Singapore Tourism Board

The city of Singapore, one of the world's busiest ports, is a bustling center of trade, finance, and manufacturing. Modern skyscrapers tower above the city's historic district, *foreground.*

laws. A prime minister and a Cabinet carry out the operations of the government. The people of Singapore elect the members of Parliament to five-year terms. The head of the political party with the most seats in Parliament serves as the prime minister of the country. The prime minister selects the Cabinet members. The People's Action Party (PAP), which is Singapore's largest political party, held all the seats in Parliament from 1968 until 1981. Since then, the People's Action Party has held almost all the seats.

The people elect a president for a six-year term. The president serves as head of state of Singapore. The president has some controls over government finances and makes key civil service appointments.

Singapore's judicial system consists of a Supreme Court and district, magistrate, and special courts. The president, on the advice of the prime minister, appoints the chief justice and the six other judges of the Supreme Court.

Singapore has about 55,000 people in its army, navy, and air force. Men must serve 2 years in the armed forces after reaching the age of 18.

People. Singapore is one of the world's most densely populated countries. More than 75 percent of Singapore's people are Chinese. Malays make up about 15 percent of the population, and most of the rest of the people are Europeans or Indians. Singapore has four official languages—Chinese, English, Malay, and Tamil.

Singapore's ethnic groups create a variety of cultures within the country. Most urban Singaporeans wear modern Western-style clothing, but some Indians and Malays prefer traditional dress. Restaurants offer an assortment of Chinese, Indian, and Malay dishes. Singapore has no official religion. Most of the Chinese in Singapore practice Buddhism or Taoism, and most Malays are Muslims. Hinduism ranks as the main religion among the Indians of Singapore, and Christianity among the Europeans.

English is the language of instruction in all schools in Singapore. The government provides six years of free primary education to children who are citizens. Singapore's literacy rate is one of the highest rates in Southeast Asia. For this rate, see **Literacy** (table: Literacy rates for selected countries). Schools of higher education in Singapore include the National University of Singapore and Nanyang Technological Institute.

Art, music, and theater reflect the cultures of Singapore's ethnic groups. The country's cultural events include Chinese operas, Indian films, and Malay dancing.

The city of Singapore lies on the southern coast of Singapore island. More than 90 percent of the country's people live in the city. Singapore is one of the world's busiest ports. Ships sailing to Australia, China, and Japan dock there to load and unload cargo. Singapore is a *free port*—that is, goods can be unloaded, stored, and reshipped without payment of import duties.

The city is built around its harbor. Warehouses and concrete docks line the port. In the crowded commercial section, modern skyscrapers tower over traditional Chinese shops. Singapore has many handsome buildings that date from the 1800's, including the National Museum and the Raffles Hotel. The Jurong area, an industrial park west of the city, has about 800 factories. The Botanical Gardens features large collections of tropical and subtropical plants.

The city's older residential sections lie near the docks. These areas have many brick and stucco shops with living quarters on the second floor. Some Malays live in bamboo houses thatched with palm leaves. The wealthier sections of the city include modern single-family homes surrounded by flowers, shrubs, and trees. Since the mid-1900's, the government has built many large apartment buildings on the main island. These buildings are part of communities called *new towns*.

Land and climate. Most of the islands of Singapore lie near sea level. The highest point, Timah Hill, is only 581 feet (177 meters) above sea level. Rain forests cover most of the central part of the main island, and mangrove swamps lie along the northern coast. A variety of wild animals, including tigers and leopards, once lived

Singapore

WORLD BOOK maps

Singapore Tourist Promotion Board

Street markets in Singapore attract shoppers from many countries. About 3 million tourists visit the city yearly.

in Singapore. However, most of them except monkeys, and snakes and some other reptiles, have become extinct because of urban development.

Singapore has a hot, moist climate. The average annual temperature is about 80 °F (27 °C). However, sea breezes cool the country, and so the temperature rarely rises above 94 °F (34 °C). The main island receives about 95 inches (241 centimeters) of rain yearly.

Economy. Singapore has a highly developed economy. The import and export activities in the port area provide jobs for many people. Singapore is also a major manufacturing center. Its factories produce such goods as chemicals, electronic equipment, machinery, metals, paper, rubber, scientific instruments, textiles and clothing, and transportation equipment. Other major industries include the processing of food and lumber, petroleum refining, and shipbuilding and repairing. In addition, Singapore is a major financial center. It has many banks and insurance and finance companies, and a stock exchange. There is little unemployment in Singapore. The country's annual income *per capita* (per person) is one of the highest in Asia.

Singapore has few natural resources, and so it must import most of the raw materials needed for manufacturing. Singapore refines crude petroleum from Saudi Arabia and other oil-producing countries for export throughout Southeast Asia and the Far East. One of Singapore's refineries ranks among the world's largest.

Only a small percentage of Singaporeans work in agriculture. The nation's farmers produce eggs, pork, poultry, orchids, and a wide variety of fruits and vegetables.

The government of Singapore plays a major role in the country's economy. For example, it decides what benefits, such as vacation time and sick leave, must be provided for workers by employers. It also operates an employment agency to help people find jobs, and it provides pensions for retired workers.

Singapore has a good transportation network. A bus system serves almost every part of the island. The island also has a rapid transit rail system. A railway links Singapore with Malaysia. Changi International Airport, on the eastern end of the island, is the nation's chief airport. The country has an average of about 1 automobile for every 12 people. Singapore has about 10 daily newspapers, at least one of which is published in each of the four official languages. The English-language *Straits Times* is the largest newspaper. Radio and television stations broadcast in all four official languages. Most families own a TV set and one or more radios.

Singapore belongs to the Association of Southeast Asian Nations (ASEAN). ASEAN is a regional organization that promotes economic, cultural, and social cooperation among its members.

History. People have lived on what is now Singapore island since prehistoric times. From about the A.D. 100's to the 1200's, the present-day city of Singapore was known as *Temasek,* or *sea town.* The name *Singapore,* which means *lion city* in the Sanskrit language, has been used for the island and the city since the 1200's. The name was probably given because of the many tigers, mistakenly called lions, that inhabited the island. During the 1200's and 1300's, Singapore harbor served as a trading center. Invaders from Java (now part of Indonesia) destroyed the entire island in 1377. Singapore then became a base for pirates and fishing fleets.

Until the early 1800's, most of Singapore was covered by jungles and swamps. A small fishing village lay on the southern coast of the main island. Sir Thomas Stamford Raffles, an agent for a British trading organization called the East India Company, realized the potential importance of the island's location to British trade. In 1819, he gained possession of Singapore harbor for Britain through an agreement with a sultan of Johor (now part of Malaysia).

All of Singapore came under British control in 1824. In 1826, it became part of the Straits Settlements, a British colony. The port prospered, and Singapore's population grew rapidly. Large numbers of Chinese settled in Singapore, and many of them became merchants.

In the 1920's and 1930's the British built air bases and a naval base on Singapore island. In 1942, during World War II, Japanese troops captured the island. They occupied Singapore island until 1945, when it was recovered by the British.

Britain dissolved the Straits Settlements in 1946 and made Singapore a separate crown colony. The people of Singapore elected their first representative legislature in 1955. Singapore gained internal self-government in 1959, but Britain remained responsible for its defense and foreign affairs.

In 1963, Singapore joined the Federation of Malaysia, which also included Malaya and the Borneo territories of Sabah (formerly North Borneo) and Sarawak. However, economic and political disputes soon developed between Singapore and the rest of Malaysia. In 1965, Singapore withdrew from the federation and became an independent nation.

Since 1959, the People's Action Party has controlled the government. Lee Kuan Yew, the party's leader, held the position of prime minister from 1959 until 1990. Singapore's economy and population have grown steadily since independence. Lee's government played a major

role in the growth of the nation's economy. In 1990, Lee resigned as prime minister and Goh Chok Tong took office. Lee remained head of the People's Action Party and became a senior minister in Goh's Cabinet. In 1992, Goh was elected head of the People's Action Party.

David P. Chandler

See also **Association of Southeast Asian Nations; Lee Kuan Yew; Raffles, Sir Thomas Stamford.**

Singapore is the capital of the country of Singapore. See **Singapore** (the country).

Singer, Isaac Bashevis (1904-1991), a Polish-born author, won the 1978 Nobel Prize for literature. Singer, who wrote in Yiddish, was the son of a rabbi. He was educated in a rabbinical seminary in Poland, and his Jewish education and Polish background form the basis of his writing. Singer's best-known tales are romantic or legendary rather than realistic. The narrators in some of his stories are imps or demons. Many of his works combine modern realism with Jewish folklore and fantasy.

Singer was born on July 14, 1904. He grew up in a poor section of Warsaw. He described his life there in *A Day of Pleasure: Stories of a Boy Growing Up in Warsaw* (1969). Singer also wrote three other volumes of autobiography: *A Little Boy in Search of God* (1976), *A Young Man in Search of Love* (1978), and *Lost in America* (1981).

Alarmed by the threat of Nazism in Europe, Singer moved to the United States in 1935. Many of his works first appeared in the *Jewish Daily Forward,* a Yiddish newspaper published in New York City, and were later translated into English. Singer is best known for his short stories, many published in *Collected Stories* (1982).

Singer's novels include *Satan in Goray* (1935), *The Family Moskat* (1950), *The Magician of Lublin* (1960), *The Slave* (1962), *Enemies: A Love Story* (1972), *Shosha* (1978), *Scum* (1991), and *Shadows on the Hudson* (published in 1997, after his death). A work serialized between 1952 and 1955 was published as two novels, *The Manor* (1967) and *The Estate* (1969). Arthur M. Saltzman

Singer, Isaac Merrit (1811-1875), an American inventor and manufacturer, did more than anyone else to make the sewing machine a universal household appliance. His skill as a machinist led him to see how the machine could be made more efficient and marketable.

Singer was born on Oct. 27, 1811, in Pittstown, New York. He worked as a machinist before turning to inventing. He developed some mechanisms similar to mechanisms in Elias Howe's sewing machine. But Singer's machine, unlike Howe's, was capable of continuous stitching. In 1851, Howe took Singer to court, accusing him of breaking patent laws. The two reached a settlement, and Singer retained the right to produce his machines.

Singer promoted the product energetically and used an early form of mass production. By 1860, his Singer Manufacturing Company had become the largest sewing machine maker in the world. In 1863, after making a fortune, he retired to England. Richard F. Hirsh

See also **Sewing machine.**

Singing is the production of musical tones by the human voice with or without words. Singing is a natural form of expression found in cultures and societies throughout the world. Singing may be accompanied by instrumental music, or it may be *a cappella* (without instrumental accompaniment).

How people sing. Singing is produced by causing a column of air to vibrate. A person sings by drawing air into the lungs and exhaling it past the *vocal cords.* The vocal cords are two folds of tissue that stretch across the *larynx* (voice box) in the throat. The movement of the air against the vocal cords and the surface of the throat and mouth causes vibrations that create the sound of the voice.

Because the vocal cords are elastic, the *pitch* (highness or lowness) of tones produced when the cords vibrate will vary, depending on the degree of tension. The tighter the vocal cords are stretched, the higher the pitch. The more relaxed the cords, the lower the pitch. A man's vocal cords tend to be longer, wider, and thicker than those of a woman. Therefore, a man's voice tends to be an octave or more lower than a woman's voice.

Voice classification. Both men's and women's voices fall into three general categories of pitch—high, middle, and low. Within these categories, voices are classified into six basic types. From highest to lowest in pitch, they are *soprano, mezzo-soprano,* and *contralto* for women; and *tenor, baritone,* and *bass* for men. Most voices belong in the mezzo-soprano and baritone categories.

Training the voice. Singing is a natural function that requires no training to perform simple music. But serious singing makes special demands on the voice. Therefore, a singer requires special training to perform opera and other difficult music. Singers study and train to develop and improve four basic singing skills: (1) breath control, (2) a broad range, (3) smoothness throughout the range, and (4) good resonance.

Breath control enables a singer to perform entire musical phrases, some quite long, in a single breath. The singer learns to breathe freely and naturally, filling the lungs from the bottom upward and expanding the chest cavity. The singer must learn how to release the air with well-regulated, evenly controlled pressure. The actions of muscles in the abdomen and chest cavities help the singer to achieve this goal.

A broad range enables a singer to correctly produce a wide span of notes from low to high. The singer's range determines his or her voice category. Training helps singers to produce the easy mid-range tones comfortably, and also the highest and lowest tones of which they are capable. Most untrained people can sing over a range of about 1 $\frac{1}{2}$ octaves or less. But trained singers usually have a range of about two octaves. Exceptional singers may develop ranges of three or more octaves.

Smoothness throughout the range means that a singer produces no audible breaks in the voice when moving from one tone to another. The singer should be able to sing smoothly throughout the range, with no abrupt changes in the quality of the tone.

Good resonance strengthens and beautifies the tone. Resonance takes place as the tone vibrates in the cavities of the throat, mouth, chest, and face. Resonance occurs naturally and by itself. *Quality* of resonance, however, is difficult to control. To do so, the singer must learn to simultaneously relax and tighten different muscles. The singer must also learn independent muscle control of the tongue, lips, and jaw.

Other singing skills. Singers should learn to read music *notation* (the signs and symbols) and understand music terms. Singers also learn how to control *vibrato,* a vibrating sound made up of slight, rapid changes in

pitch. Clear *diction* (speech) is important so the lyrics can be clearly understood. Katherine K. Preston

Related articles in *World Book* include:

Biographies

For biographies of opera and popular singers, see the *Related articles* at the end of the Opera and Popular music articles.

Other related articles

Barbershop quartet singing	Classical music	Meistersinger	Opera
Bard	Country music	Minnesinger	Operetta
Blues	Folk music	Minstrel	Oratorio
Calypso	Hymn	Music	Rock music
Canon	Jazz	Musical comedy	Song
Cantata	Larynx	National anthem	Troubadour
			Trouvère
			Voice

Additional resources

Brown, Oren L. *Discover Your Voice: How to Develop Healthy Voice Habits.* Singular Pub. Group, 1996.
Davis, Peter G. *The American Opera Singer.* Doubleday, 1997.
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Single tax is a type of property tax. The term is usually applied to a system of land taxation that was supported in the late 1800's by Henry George, an American social reformer. The system was never put into general use.

Henry George said that a tax on land should be the only source of money for the government. He believed landowners receive all the wealth from the use of their land, but do nothing to earn the wealth. A small plot of rocky soil on New York City's Manhattan Island is worth a fortune solely because millions of people live there. This increased value of land, called *unearned increment,* is due not to the owner's effort but to population growth and other factors beyond the owner's control.

Single taxers argue that since the whole population gives the land its value, the whole population should share it. They urge that the government should, by taxation, take the entire unearned increment from land and use it for the public good. However, most economists doubt that a single tax would provide enough funds to pay all the government's expenses. Vito Tanzi

See also George, Henry.

Sinkiang. See Xinjiang.

Sinn Féin, *shihn fayn,* is an Irish nationalist political party. The Gaelic words mean *We Ourselves.* Sinn Féin helped achieve an independent Irish republic. Today, it is the political wing of the Irish Republican Army (IRA), a group that has sometimes used violence in trying to free Ireland, and, later, Northern Ireland, from British rule.

Irish journalist Arthur Griffith formed Sinn Féin as a nationalist organization in 1905. At the time, all of Ireland was part of the United Kingdom. In 1916, some Sinn Féin members took part in a revolt against the United Kingdom during the Easter season. Although British troops put down the rebellion, it increased Sinn Fein's popularity. In 1919, Sinn Féin members of the British Parliament met separately as an Irish national assembly, the *Dáil Éireann (dawl AIR uhn).* The leaders were Griffith, Michael Collins, and Eamon de Valera.

In 1921, the Anglo-Irish Treaty established the Irish Free State in the south of Ireland but allowed Northern Ireland to remain a part of the United Kingdom. Most of the people in the Irish Free State were Roman Catholics, and most of those in Northern Ireland were Protestants. Both the IRA and Sinn Féin were divided over the treaty, and a civil war began in 1922. Those opposed to the treaty, led by de Valera, were defeated within a year.

In 1926, de Valera left Sinn Féin and formed a new party, *Fianna Fáil* (Soldiers of Destiny). Sinn Féin lost much of its political influence. In 1937, the Irish Free State changed its name to *Éire* (in Gaelic) or Ireland (in English). In 1949, Ireland became an independent nation.

Beginning in the late 1960's, Sinn Féin and the IRA became active again, but mainly in Northern Ireland. The IRA battled the British Army and Protestant militants, and Sinn Féin ran candidates for political office.

In 1998, Sinn Féin and the other parties in the Northern Ireland conflict reached a peace agreement. However, full implementation of the agreement was delayed by mistrust and political maneuvering. Paul E. Gallis

See also Adams, Gerry; De Valera, Eamon; Griffith, Arthur; Ireland (The Easter Rising); Irish Republican Army; Northern Ireland (Recent developments).

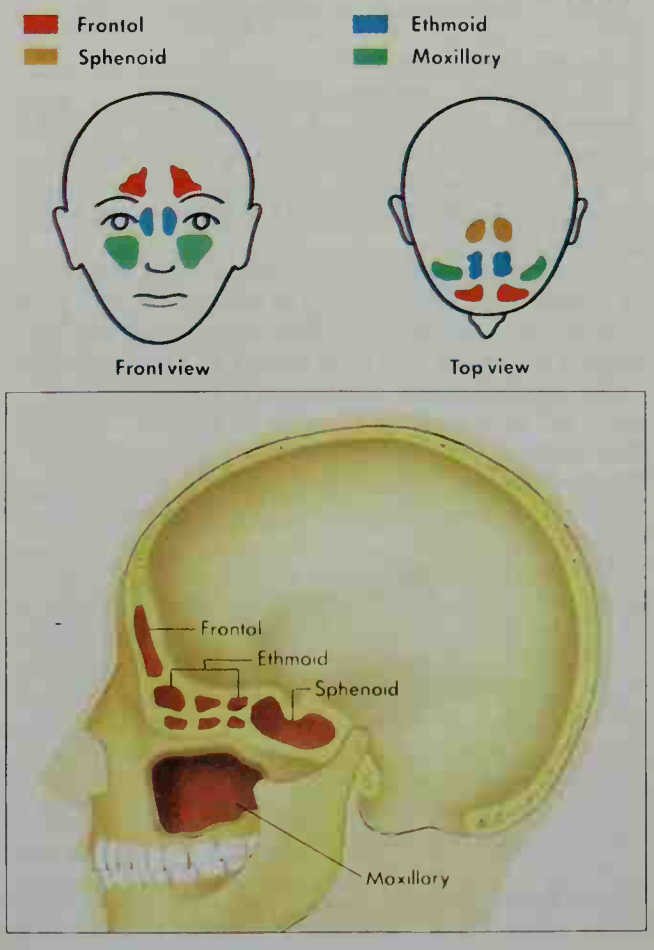
Sino-Japanese wars. See Chinese-Japanese wars.

Sinus, *SY nuhs,* is a cavity in the bodies of animals, including human beings. When used alone, the term *sinus* generally refers to a hollow, air-filled space in the front of the skull. The human skull contains four groups of sinuses. Doctors sometimes call these groups the *para-*

Location of the sinuses

Human beings have four pairs of sinuses. These cavities lighten the skull and make it easier to balance on the neck. Sinuses also provide drainage of mucus produced by sinus membranes.

WORLD BOOK illustrations by Charles Wellek



nasal sinuses, because they all connect with the nasal cavity. Each group of sinuses takes its name from the bones of the skull in which it is found.

The *frontal* sinuses are in the frontal bone of the forehead just above the eyes. The *maxillary* sinuses, largest of the paranasal sinuses, are in the cheekbones on each side of the nose. The *ethmoid* sinuses lie just above the nasal cavity, and the *sphenoid* sinuses are behind them. The sinuses lighten the skull, and make it easier to hold up the head and to balance it on the neck. They also cushion the brain from blows to the front of the skull.

The sinuses are lined with the same kind of membranes as those that line the nose (see **Membrane**). Infections of the nose spread easily to the sinuses. There, the infection causes a disease commonly called *sinus trouble,* or *sinusitis.* In sinusitis, the inflamed mucous membranes in the sinuses become swollen, closing the opening and preventing infected material from draining out. When this happens, painful pressure builds up in the sinuses. This pain may occur at the same time every day. Other symptoms of sinus trouble may include dizziness and a running nose. Allergies, colds, influenza, and many other diseases often result in sinus symptoms. Other factors that may make some people more susceptible to sinusitis include dampness, drafts, and smoking.

The treatment of sinus trouble includes rest and liquid diet. Antibiotics and pain-relieving drugs are helpful. Sometimes surgery may be used to puncture a maxillary sinus and permit proper drainage, or to remove the abnormal sinus membrane. Sinus trouble is dangerous because it may serve as a center of infection that spreads to other parts of the body, such as the eye or brain.

Sinuses occur only in mammals, birds, and crocodiles. The huge sphenoid sinus of the elephant extends to the very back of the skull. Barry L Wenig

See also **Cold, Common; Head; Hay fever.**

Sioux City, *soo* (pop. 85,013; met. area pop. 124,130), is a commercial and manufacturing center in western Iowa. It lies on the Missouri River, near where Iowa, Nebraska, and South Dakota meet. For location, see **Iowa** (political map).

Sioux City is surrounded by a farm region, and much of its industry involves trading or processing farm products. IBP, Inc., the world's largest processor of beef and pork, is across the river from Sioux City. Other industries in the area include the processing of honey and popcorn, and production of animal feed, fertilizer, tools, and truck trailers. The city serves as a port for barge traffic on the Missouri River. It is the home of Briar Cliff College, Morningside College, and Western Iowa Tech Community College.

The Floyd Monument rises 100 feet (30 meters) on a bluff overlooking the Missouri River. It marks the grave of Charles Floyd, a U.S. Army sergeant who died while exploring the area with the Lewis and Clark expedition in the early 1800's. Sioux City was laid out in 1854 by John K. Cook, a surveyor. The city was named after the Sioux Indians, many of whom were friendly to white settlers in the area. It has a council-manager form of government and is the seat of Woodbury County. For the monthly weather in Sioux City, see **Iowa** (Climate).

Larry Myhre

Sioux Falls, *soo* (pop. 123,975; met. area pop. 172,412), is the largest city and leading commercial and livestock center in South Dakota. It lies at the falls of the Big Sioux River (see **South Dakota** [political map]). The city's products include crushed rock, electromagnetic equipment, electronic equipment, fabricated steel, high-altitude balloons, millwork, packaged meats, and processed dairy foods. It is also the headquarters for two credit-card companies. The city has several hospitals, a state school for the deaf, and the state prison. It is the home of Augustana College, the University of Sioux Falls, and the Washington Pavilion of Arts and Science.

Sioux Falls was first settled in 1856. It has a mayor-council government. For the monthly weather in Sioux Falls, see **South Dakota** (Climate). David Kranz

Sioux Indians, *soo,* traditionally lived throughout the northern plains of North America. The Sioux were famous for their bravery, fighting ability, and political skills. The Sioux had many divisions. The Santee, or Dakota, Sioux lived in what is now Minnesota. The Yankton, or Nakota, Sioux lived in the eastern Dakotas. Both of these groups hunted and farmed. The Lakota, or Teton, Sioux hunted buffalo in the western Dakotas and in Nebraska.

During the middle and late 1800's, white settlers and gold seekers overran Sioux hunting grounds and killed many buffalo. The Santee rebelled in 1862 and fled westward. In 1868, some of the Lakota agreed to live on a reservation. But they had no experience in farming, and land on the reservation was poor. Other Lakota remained outside the reservation. Leaders of this group included Sitting Bull and Crazy Horse. In 1876, after the group had refused government orders to enter the reservation, Lieutenant Colonel George A. Custer led his troops against them. The Sioux killed Custer and every man in his immediate command in "Custer's Last Stand." Later, U.S. Army troops forced them to enter the reservation. In 1890, the Ghost Dance cult, introduced by Wovoka, brought new hope to the Sioux (see **Wovoka**). Army leaders thought that the Indians meant to revolt, and they attacked them. See **Indian wars** (The Sioux wars).

Today, about half of all Sioux live on reservations in the northern plains. The other half live in urban areas throughout the United States. In 1973, a dispute over tribal leadership broke out among the Oglala Lakota Sioux of the Pine Ridge Reservation in South Dakota. Partly as a result of the dispute, a group that included members of the American Indian Movement (AIM) seized the village of Wounded Knee on the reservation and occupied it for 71 days. See **South Dakota** (The mid-1900's).

In 1980, the Supreme Court of the United States ordered the federal government to pay about $105 million to eight Sioux tribes for Indian land in South Dakota that the government had taken illegally in 1877. The tribes refused the settlement and sought the return of part of the Black Hills in South Dakota as well as a cash payment.

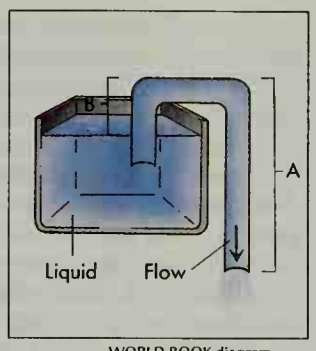
Jo Allyn Archambault

Related articles in *World Book* include:

Crazy Horse	Red Cloud
Gall	Sitting Bull
Indian, American (illustration: Indian ways of life; picture: Sun dance)	Spotted Tail
	Sun dance
	Wounded Knee

Siphon, *SY fuhn,* is a device used to draw liquid over the edge of a container and transfer it to a lower level. It

is usually a tube bent into the shape of an inverted U or J. Siphons have many uses. For example, siphons are used in plumbing and irrigation systems.



WORLD BOOK diagram by Oxford Illustrators Limited
Siphon

To operate a siphon, first put one end of the tube into a container of liquid. Next, place the other end at a level lower than the surface of the liquid. Then, apply suction to the lower end to fill the tube. When you release the suction, liquid will continue to flow upward into the tube and down and out the lower end.

In some siphons, the liquid flows out into a second container, whose liquid level is lower than that of the first container. Siphoning action continues until the liquid in both containers reaches the same level.

A siphon works because of gravity. As shown in the accompanying illustration, the part of the siphon labeled A contains more liquid than does the part labeled B. The liquid in both parts tends to fall. For all the liquid to fall, however, liquid at the top of the siphon would have to break apart. Forces between the liquid's molecules hold the liquid together, so only the liquid in part A falls. As it falls, it pulls liquid in the other part of the tube through the tube, and it pulls liquid in the container up into the tube. John B. Butt

Siphonaptera. See Insect (table).

Siqueiros, *see KAY raws,* **David** (1896-1974), was a Mexican painter famous for his vigorous and colorful murals on political themes. Many of his murals deal with Mexican and Latin American history. They reflect his opposition to tyranny and his sympathy with workers and the victims of oppression. Siqueiros was frequently imprisoned for his left-wing political views.

Siqueiros experimented with modern materials and techniques, such as a spray gun and synthetic paints. Through these experiments, he was able to give his works a three-dimensional quality. Siqueiros conceived of his murals as dynamic rather than static images. He treated the painted walls as one continuous surface, with the subject matter carrying over onto adjacent walls without a break.

David Alfaro Siqueiros was born in Chihuahua, Mexico. He studied art in Europe from 1919 to 1922 and painted his first murals in 1922. In the early 1930's, Siqueiros painted murals and exhibited his work in Los Angeles and New York City as well as in Uruguay and Argentina. He was expelled from the United States in 1932 for a controversial painting. He created famous murals in Mexico City in the Union of Electricity Workers headquarters (1939) and the Museum of National History (1964), and in a school library in Chillán, Chile (1942). Jacinto Quirarte

See also **Mexico** (Arts: picture); **Latin America** (Arts; picture); **Painting** (Synthetic resins; picture).

Sirenia, *sy REE nee uh,* is the name of an *order* (group) of water mammals related to elephants and hyraxes. The two living families are the dugongs and manatees (see **Dugong**; **Manatee**). The name *Sirenia* came from an old belief of sailors that dugongs and manatees were sirens or mermaids. Sirenians live in the shallow waters along tropical seacoasts and in lagoons, swamps, and rivers. They feed on aquatic plants. Sirenians are regarded as threatened or endangered species worldwide. It is illegal to hunt them in most countries. Their low rate of reproduction makes it difficult for sirenian populations to grow. Daniel K. Odell

See also **Sea cow.**

Sirens were sea nymphs in Greek mythology who lived on an island. Two Sirens are mentioned in the Greek epic poem the *Odyssey.* Most later authors wrote about three. The Sirens' sweet singing lured sailors to destruction on their island's rocky shores. In some stories, the Sirens would die if someone sailed past unmoved by their singing. The hero Odysseus (Ulysses in Latin) put wax in his sailors' ears so they could not hear the Sirens. Then he had them tie him to the mast. Odysseus could thus listen to the Sirens without endangering his ship. In art, Sirens were first portrayed as birds with women's heads and later as women with birds' legs and sometimes wings. See also **Odyssey** (picture); **Capri.** Cynthia W. Shelmerdine

Sirius, *SIHR ee uhs,* also called the *Dog Star,* is the brightest star that can be seen from the earth at night. Sirius has a diameter more than twice as large as that of the sun and gives off nearly 30 times as much light. It is a star of the first *magnitude* (see **Star** [Brightness of stars]).

Sirius forms part of *Canis Major,* a constellation located in the sky of the Southern Hemisphere. Sirius is one of the stars nearest the earth. It is about nine *light-years* away. A light-year, the distance that light travels in a year, equals about 5.88 trillion miles (9.46 trillion kilometers).

Astronomers classify Sirius as a *binary star* because it has a companion star, *Sirius B* (see **Binary star**). Sirius B is a *white dwarf,* an extremely dense star that can be as small as the earth. It consists of matter that is 4 million times as dense as water. If matter from Sirius B were brought to the earth's surface, it would weigh approximately 120,000 tons per cubic foot (4,000,000 metric tons per cubic meter). Because of its tremendous density, Sirius B exerts a strong gravitational pull on Sirius. This powerful gravitational force causes Sirius to move in a wavy line as it travels through space. Sirius and Sirius B make a complete orbit around each other about every 50 years. Sumner Starrfield

See also **Calendar** (Early calendars); **Relativity.**

Sirocco, *suh RAHK oh,* is the Italian name for a warm wind that blows northward from the hot, dry Sahara or Arabian Desert. It occurs frequently during the spring in European countries on the north side of the Mediterranean Sea. A sirocco may pick up moisture as it crosses the Mediterranean and arrive at European shores as a warm, damp wind. As it moves north, it produces fog and rain. Some siroccos carry desert dust. When a dry sirocco blows, fine sand darkens the sky. The wind burns the skin and parches the throat. The term *sirocco* is sometimes applied to any unseasonably warm south winds in the Mediterranean region. Richard A. Dirks

Sisal, *SIHS uhl,* also called *sisal hemp,* is the name of a plant grown for its strong fiber. The fiber, also known as *sisal,* is obtained from the plant's swordlike leaves. It is

used to make twine, rope, doormats, bags, and other items. The sisal plant is named after the Mexican port town from which sisal fibers were first exported. Today, sisal is mostly grown in dry regions of Brazil, Tanzania, Angola, Kenya, and Madagascar.

The leaves of the sisal plant grow about 5 feet (1.5 meters) long. Manufacturers remove the fibers through a process called *decorticating*. In this process, the leaves are mechanically crushed to squeeze out soft plant material and juices. The coarse fibers are then scraped, washed, and dried. The sisal plant is sometimes called the *century plant* because people believed it bloomed only once in 100 years (see **Century plant**).

Thomas B. Croat

Scientific classification. Sisal is in the agave family, Agavaceae. Its scientific name is *Agave sisalana*.

Siskin, Pine. See Pine siskin.

Sisley, *SIHS lee* or *sees LAY,* **Alfred** (1839-1899), was an impressionist artist best known for his landscape paintings. Sisley captured a variety of effects in his landscapes, ranging from full sunlight to gloomy mist. His best pictures are delicately painted and reveal a more spacious, airy feeling than those of his fellow impressionists. Sisley particularly excelled in portraying snow scenes.

Sisley was born in Paris of English parents. In the early 1860's, he studied in the Paris studio of the Swiss artist Charles Gleyre. There, he met the future impressionists Jean Frédéric Bazille, Claude Monet, and Pierre Auguste Renoir. Sisley's early pictures emphasized dark browns and greens. By 1870, he was using lighter colors and painting more spontaneously. He did his most successful work in the 1870's.

Richard Shiff

See also Impressionism.

Sistine Chapel, *SIHS teen,* is a famous chapel in the palace of the Vatican in Rome. It was erected by Pope Sixtus IV in 1473. The chief papal ceremonies take place in this chapel. The chapel also is where the cardinals vote for a new pope. Canonizations and other ceremonies are held in St. Peter's Basilica.

The Sistine Chapel is a simple building, 134 feet (41 meters) long by 44 feet (13 meters) wide, and 85 feet (26 meters) high. But it has on its walls and ceiling some of the greatest art ever produced in the Western world. Brilliant artists of the late 1400's decorated the walls with paintings that tell the stories of Moses and Christ. On the ceiling are Biblical stories painted by the great artist Michelangelo between 1508 and 1512. The stories tell the history of the creation of the world, the fall of hu-

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The Sistine Chapel is in the Vatican Palace in Rome. The Italian artist Michelangelo decorated the ceiling with paintings of Biblical stories. He painted *The Last Judgment* on the wall behind the altar. Other artists painted the side walls with stories of Moses and Jesus Christ.

manity, and the flood. On the wall above the altar is *The Last Judgment,* a painting 60 feet (18 meters) high and 30 feet (9 meters) wide. Michelangelo worked on *The Last Judgment* between 1536 and 1541. David Summers

Pictures of paintings in the Sistine Chapel are reproduced in the articles **David; Isaiah, Book of; Jeremiah, Book of; Painting** (The High Renaissance); and **Religion.**

Sisyphus, *SIHS uh fuhs,* was the founder of the city of Corinth in Greek mythology. He was a notorious trickster, who deceived even the gods.

Sisyphus once outwitted the god Thanatos (Death). Zeus, ruler of the gods, had sent Thanatos to punish Sisyphus for revealing one of Zeus's love affairs. Sisyphus managed to capture Thanatos and bind him in chains. No one died while Thanatos was bound. The god Ares freed Thanatos and gave him power over Sisyphus. Then Sisyphus told Merope, his wife, to bury him without the usual funeral rites. After he died and went to Hades, the land of the dead, Sisyphus begged to be allowed to return to earth to punish his wife for failing to give him a proper burial. After gaining his release, Sisyphus refused to return to Hades.

The god Hermes finally captured Sisyphus and placed him under the control of Hades, ruler of the land of the dead. Sisyphus was forced to roll a huge stone to the top of a hill. Each time Sisyphus was about to roll the stone over the summit, it pushed him back to the bottom of the hill. Justin M. Glenn

Sitar, *sih TAHR,* is a stringed instrument that originated in India or Persia. It is used in the classical music of northern India, Pakistan, and Bangladesh. The sitar has a long, broad neck made of wood and a pear-shaped body made from a large gourd. It has 7 main strings, which the musician plucks with a wire pick worn on the right index finger. It also has 12 or more *sympathetic strings.* These strings vibrate when the main strings are played. Adjustable metal strips called *frets* are attached to the neck of the instrument. They serve as fingering guides for the left hand.

The sitar probably was developed in the A.D. 1200's. It reached its present form during the 1800's and 1900's. It serves chiefly as a solo instrument, usually accompanied by a drum called a *tabla* and a lute called a *tambura* that produces a *drone* (continuous pitch). A sitarist improvises within a certain melodic framework known as a *raga* and a metrical framework called a *tala.* The instrument has become more familiar in the West since the 1960's. The Beatles and other rock groups have used it in their music. Valerie Woodring Goertzen

Marilyn Silverstone, Magnum

The sitar is used primarily to play classical music of northern India, Pakistan, and Bangladesh. The Indian musician Ravi Shankar, *shown here,* is a leading sitarist.

Sitka, *SIHT kuh,* Alaska (pop. 8,835), is one of the oldest cities on the west coast of North America. It lies in southeast Alaska on the west coast of Baranof Island. For the location of Sitka, see **Alaska** (political map).

No roads lead to Sitka. The city can be reached only by air or water. Tlingit Indians make up about 20 percent of the population, and Sitka is a center of Alaska native arts and culture. The city is the home of Sheldon Jackson College and a campus of the University of Alaska. Sitka's attractions include St. Michael's Cathedral, the Sheldon Jackson Museum, Sitka National Historical Park, and Castle Hill. The hill is the site of the 1867 ceremony in which ownership of Alaska was transferred from Russia to the United States. Sitka hosts a classical music festival each June.

Sitka's largest employer is the Southeast Alaska Regional Health Consortium, which operates a large hospital for Alaska natives. Commercial fishing and fish processing are important economic activities. The catch includes black cod, halibut, and salmon.

Sitka was founded on its present site in 1804 by Alexander Baranof, a Russian trader. An earlier settlement on another site had been destroyed by Indians. From 1807 until 1867, Sitka was the capital of Russian America and the headquarters of the Russian-American Company's sea otter fur-gathering enterprises. It was the capital of the U.S. district of Alaska from 1884 until 1900. In 1972, the City of Sitka merged with the Greater Sitka Borough to form the City and Borough of Sitka. Sitka has a council-manager form of government. Thad Poulson

Sitting Bull (1834?-1890) was a famous medicine man and leader of the Hunkpapa band of the Teton Sioux Indians. Many people think that he was the leader of the Indians at the battle of the Little Bighorn, on June 25, 1876, in which Lieutenant Colonel George A. Custer died. Actually, Sitting Bull acted only as the leading medicine man in the preparations for the battle. The year before, he had received a vision that all his enemies would be delivered into his hands. In the spring of 1876, Sitting Bull led a sun dance at which he told the Indians to change their way of fighting. Instead of showing off to prove their bravery, they should fight to kill, or they would lose all their lands to the white people. This new tactic led to the victory over Custer.

Brown Bros.

Sitting Bull

After the battle of the Little Bighorn, Sitting Bull and his followers were driven into Canada. He returned to the United States in 1881. After two years in confinement at Fort Randall in South Dakota, he lived on the Standing Rock Reservation in that state. There, in 1890, he helped start the Ghost Dance. The government thought this was an attempt to renew the Indian wars, and sent Indian police officers to arrest Sitting Bull. In the process, he and his son were killed.

Sitting Bull was born in what is now South Dakota. As a boy, he was known as *Hunkesni,* which meant *Slow.* However, after showing great bravery in a fight against the Crow Indians, he received the name *Sitting Bull.* His father chose the new name. Beatrice Medicine

See also **Custer, George A.; Indian wars** (The Sioux wars); **Sioux Indians; South Dakota** (Territorial days).

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Sitwell, Edith (1887-1964), was an English poet, critic, and biographer. She became one of the most controversial literary personalities of her time because of her experimental, often obscure, poetry and her eccentric lifestyle. Sitwell was known for her striking clothing, which included spectacular hats, flowing medieval robes, and enormous pieces of jewelry.

In her argumentative writings, Sitwell attacked the low level of taste she saw in English society. She criticized snobbish social attitudes with poetry that emphasized patterns of sound and imagery. For example, in *Gold Coast Customs* (1929), Sitwell employed the rhythms of African music to create a satiric comparison between a tribe of African cannibals and society in England during the 1920's. Sitwell expressed her deep religious feeling and her passionate response to the horrors of World War II in such collections as *Street Songs* (1942). Sitwell also wrote biographies of English royalty and authors, a novel, and literary and music criticism. Her autobiography, *Taken Care Of,* was published in 1965, after her death.

Cecil Beaton, Camera Press from Photo Trends

Edith Sitwell

Sitwell was born in Scarborough into an aristocratic family. In 1923, she created a sensation with her public reading of *Façade* (1922), a sequence of 21 poems set to music composed by Sir William Walton. Queen Elizabeth II made her a Dame Commander in the Order of the British Empire in 1954, and she became known as Dame Edith Sitwell.

Sitwell's younger brothers, Sir Osbert Sitwell and Sir Sacheverell Sitwell, also became well-known authors. Sir Osbert's most enduring work was probably his five-volume autobiography (1944-1950). Sir Sacheverell gained recognition for his travel books and for his studies of art and architecture. Avrom Fleishman

Siva. See Shiva.

Six-Day War. See Israel (History).

Six-shooter. See Handgun.

Sixtus IV (1414-1484) was among the most notorious of the Renaissance popes. He was elected pope in 1471, and Italian politics dominated much of his reign. Sixtus was also a great patron of Renaissance learning and the arts.

Sixtus was born in Celle Ligure, Italy, near Savona. His given and family name was Francesco della Rovere. He joined the Franciscan religious order and gained fame as a theologian. After his election, his spiritual concerns receded as he enriched family members with papal offices and named six nephews cardinals. Sixtus became involved in a family plot to assassinate Lorenzo de' Medici, the leader of Florence, and his brother Giuliano. Lorenzo was wounded and Giuliano was killed. A series of wars between the papacy and rival Italian powers followed.

Sixtus tried to transform Rome into a center of Renaissance culture. He provided the first permanent home for the Vatican Library; supported the studies of the Roman Academy; and built the Sistine Chapel, named for him, in the Vatican (see **Sistine Chapel**). Sixtus also began the urban transformation of Rome from a medieval to a Renaissance city. Charles L. Stinger

Sixtus V (1520-1590) was elected pope of the Roman Catholic Church in 1585. Sixtus was responsible for an enduring reorganization of the papacy, creating a more centralized and efficient papal administration. He set the number of cardinals at 70 and organized them into 15 *congregations* responsible for all the church's spiritual and *temporal* (nonreligious) affairs.

Sixtus left a lasting imprint on Rome. He undertook an extensive construction program, including aqueducts, the Lateran Palace, and the dome of St. Peter's Basilica. Sixtus built a network of broad, straight avenues that linked Rome's major basilicas. Soon after his election, Sixtus ruthlessly regained control of an area in central Italy called the Papal States. The pope accumulated a huge treasury surplus through increased tax revenues combined with his personal thrift and administrative skills.

Sixtus was born in Grottammare, Italy, near San Benedetto del Tronto. His given and family name was Felice Peretti. He joined the Franciscan order at the age of 12 and gained fame as a traveling preacher. In 1566, he became vicar-general of the order. He was named a cardinal in 1570. Charles L. Stinger

Skagerrak, *SKAG uh rak,* is an arm of the North Sea that separates Norway from Denmark to the south. The Skagerrak is about 150 miles (240 kilometers) long and 80 miles (130 kilometers) wide. The Skagerrak and the Kattegat—a body of water between Sweden and Denmark—form an important channel that links the North Sea and the Baltic Sea. The Skagerrak's Danish shores have no good harbors because of dangerous sand banks. But along its Norwegian coast, good harbors are plentiful. For the location of the Skagerrak, see **Europe** (terrain map). Osa E. Brand

Skald, *skawld* or *skahld,* the Icelandic word for poet, refers to the Scandinavian poets of the Middle Ages.

From the 900's through the 1200's, most court poets in Scandinavia came from Iceland. Most skaldic poetry honored the rulers whom the skalds served. Many of these poems, or parts of them, are preserved in the Icelandic *sagas* of the 1100's and 1200's. Skaldic poetry was very complex in form. It had regulated patterns of *alliteration* (linking words by repetition of their first sound) and *consonance* (a kind of rhyme between syllables containing different vowels but ending in the same consonant). Skaldic poetry also used a type of extended metaphor called a *kenning.* Richard N. Ringler

See also Edda; Saga.

Skate is the name of a family of *rays.* It is related to the shark. The skate may grow from 1 to 6 $\frac{1}{2}$ feet (0.3 to 2.0 meters) long and may weigh as much as 100 pounds (45 kilograms). It has two pairs of fins on the sides of its body. The front pair is huge and connects the body with the head. These fins have a round edge and form a disk with the body and head. The skate has a slender tail that is used as a rudder. The tail contains electric organs that help the skate locate prey. The skate eats snails, mussels, clams, crabs, and other fish. This fish makes its home on the sandy and muddy bottoms along shores or in deep water. The skate lays egg cases, often called *mermaids' purses,* on these bottoms.

Some kinds of skate are sold as food. One of the best-known species is the *little skate,* found along the Atlantic Coast of North America. This skate is 1 to 2 feet (30 to 61 centimeters) long. A larger skate that lives along the Atlantic Coast is the *barn-door skate.* The *big skate* is a species found along the Pacific Coast. John D. McEachran

Scientific classification. The skate is in the skate family, Rajidae. The little skate is *Raja erinacea;* the barn-door skate is *R. laevis;* and the big skate is *R. binoculata.*

See also Stingray (with picture).

Skateboarding is a popular sport and form of recreation in which an individual rides a small, narrow board mounted on four wheels, called a *skateboard.* The skateboarder balances on top of the *deck* (board) in the manner of riding a snowboard or a surfboard. Professional skateboarders perform in competitions that are held on specially constructed ramps, or they race on the street. Some people use skateboards for transportation.

© Grant Brittain

A professional skateboarder performs an aerial maneuver. He wears protective elbow and knee pads and a safety helmet.

A typical modern skateboard consists of six or seven layers of hard maple plywood. Polyurethane wheels and precision bearings permit smooth rides and gentle turns. For safety, skateboarders wear protective helmets, knee pads, elbow pads, wrist pads, or gloves.

Skateboarding traces its origins back to scooters made of wooden crates in the 1920's. Skateboarding first gained popularity in the late 1950's with the growth of surfing. High-performance clay-wheeled skateboards appeared by the early 1960's, and polyurethane wheels were developed in 1973. Jim Fitzpatrick

Skating. See Ice skating; Roller skating.

Skeena River is one of the world's most valuable salmon fishing grounds. It rises in north-central British Columbia and flows southwest to the Pacific Ocean. It is about 360 miles (580 kilometers) long and drains an area of about 20,800 square miles (54,000 square kilometers). The Skeena empties into Hecate Strait about 10 miles (16 kilometers) south of Prince Rupert. Graeme Wynn

Skeet is an American form of clay target shooting. As in trapshooting, the target is thrown into the air from a metal-sprung trap. Two target houses are located 42 yards (38 meters) apart. The targets spring from each house over the center post between the two houses, and at different angles of flight so as to approximate closely the effect of shooting at winged game.

Seven shooting stations, corresponding to the half face of a clock, are located on a 21-yard (19-meter) radius. Another is in the center of the circle, halfway between the two target houses. Shooters, using shotguns, fire from each station. Most targets are thrown as single shots, alternating from each house. But some targets spring out in pairs, one from each target house, at different levels. The shooter tries to bring both of the targets down. The name *skeet* comes from a Scandinavian form of the word *shoot.* Carola Mandel

See also Trapshooting.

Skeleton is the flexible, bony framework of any vertebrate animal. It gives the body shape, protects vital organs, and provides a system of levers, operated by muscles, that enables the body to move. The skeleton houses *bone marrow,* the blood-forming tissues. It stores such elements as calcium and phosphorus and releases them to the blood. It also has smaller amounts of the elements magnesium, potassium, and sodium.

The human skeleton

The human skeleton has about 206 separate bones. That is, a human being generally forms that many bones out of cartilage while developing to maturity. Sixty bones are in the hands and arms alone.

Bones are joined to neighboring bones by joints. Joints are either immovable, as in the skull, or movable, as in the arms and legs. The bones fit together and are held in place by strong bands of flexible tissue called *ligaments.* The human skeleton is divided into two main parts, the *axial skeleton,* and the *appendicular skeleton.*

The axial skeleton is made up of the bones of the head, neck, and trunk. The spine (*spinal column* or *backbone*) forms an axis that supports the other parts of the

body. The skull is at the top of the spine. The spine consists of separate bones, called *vertebrae,* with fibrous disks between them. Seven bones make up the *cervical vertebrae* (neck bones). The 12 *thoracic* vertebrae are at the back of the chest.

The ribs are attached to the thoracic vertebrae. There are usually 12 ribs on each side of the body. The upper ribs fasten in front to the *sternum* (breastbone). The ribs protect the heart and lungs, and act as a bellows box for the breathing process.

The five *lumbar* vertebrae lie in the lower part of the back. Below the last lumbar vertebra is the *sacrum.* In babies, five separate bones make up the sacrum. In adults, these bones have grown together into one solid structure. The pelvis is attached to the sacral segment of the spine by *sacroiliac joints.* The coccyx is at the bottom of the spine. In children, four separate bones make up the coccyx. The three lowest of these bones often fuse together during adulthood to form a beaklike bone. The point where the sacrum and coccyx meet remains fibrous throughout life.

The appendicular skeleton is made up of the bones of the arms and legs and their supports. The *shoulder girdle* consists of the *scapula* (shoulder blade) and the *clavicle* (collarbone). The skeleton of the arm is divided into the *humerus* (upper arm); *radius* and *ulna* (forearm); *carpus* (wrist bones); *metacarpus* (palm); and *phalanges* (fingers). The bones of the leg consist of the *femur* (thigh); *tibia* and *fibula* (leg); *tarsus* (back of the foot); *metatarsus* (forefoot); and *phalanges* (toes). The leg is attached to the trunk by a *pelvic girdle* made up of two hipbones. Each consists of three bones, the *ilium,* the *ischium,* and the *pubis.* These bones are fused in adults.

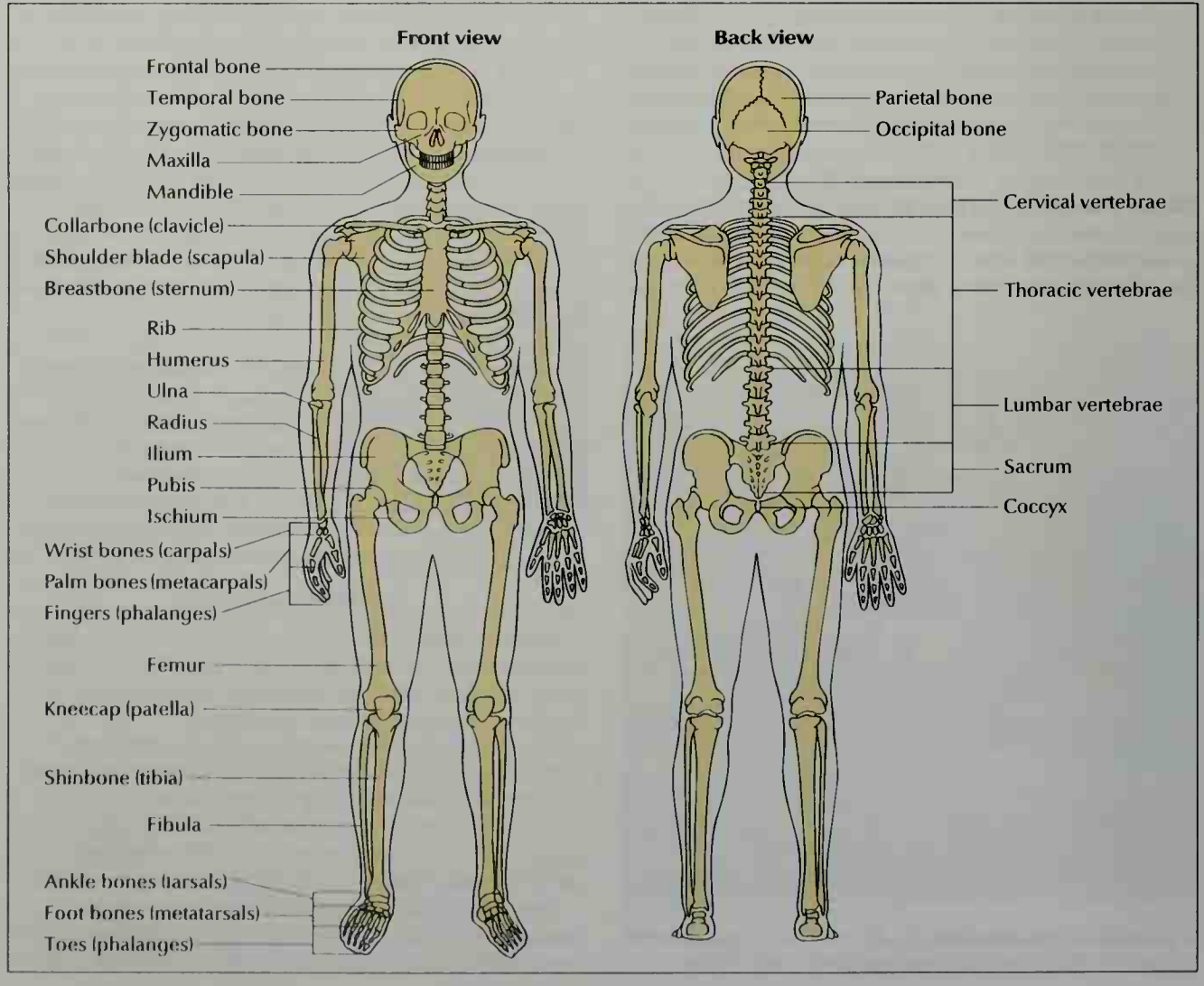
Animal skeletons

Most backboned animals have two pairs of limbs, front and hind limbs. A giraffe's neck has the same number of bones as a mouse's neck, although the giraffe's bones are longer and larger. Most mammals are *quadrupeds.* That is, they run on all four legs. Human beings are *bipeds* because they walk on only two legs. Many animals without backbones, such as insects and lobsters, have hard body coverings. This *exoskeleton* (external framework) provides both support and protection for the soft parts of their bodies. John R. Conway III

Related articles. See the Trans-Vision pictures with

The human skeleton The skeleton is a strong, flexible framework that supports the body and protects the internal organs. It also provides a system of levers, operated by the muscles, that enables the body to move. The human skeleton consists of about 206 bones, some of which are *fused* (joined) in adults.

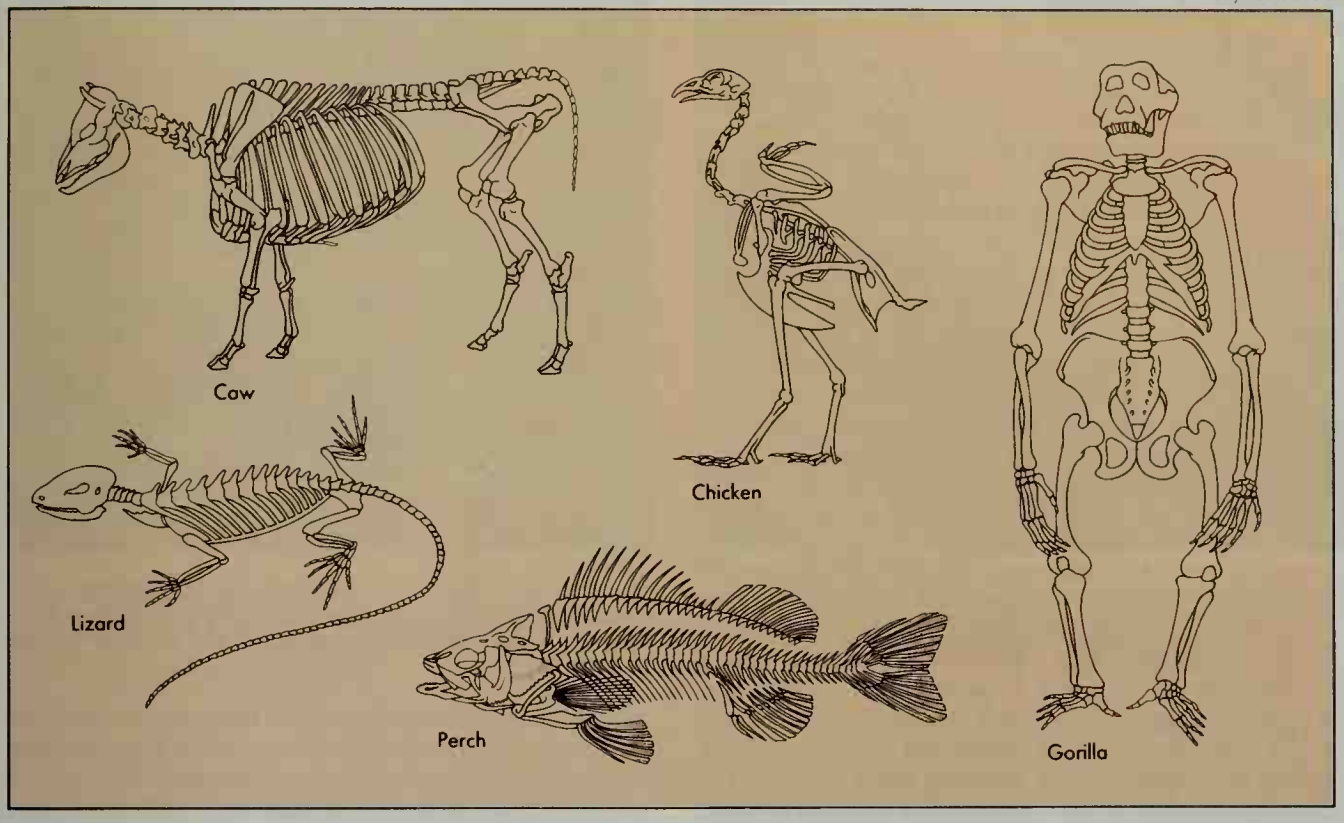
WORLD BOOK illustrations by Zonca Dabich



Some kinds of animal skeletons

All vertebrates share a basic skeletal pattern of an *axial skeleton* and an *appendicular skeleton*. The axial skeleton consists of the skull, the spinal column, and the ribs. The appendicular skeleton is made up of the bones of the appendages—arms, legs, wings, or fins—and their supports.

WORLD BOOK illustrations by Zorica Dabich



Human body. For pictures of animal skeletons, see the specific articles, such as Cat. See also:

Ankle	Hip	Pelvis
Arm	Invertebrate	Rib
Bone	Joint	Shoulder
Collarbone	Knee	Skull
Foot	Leg	Spine
Hand	Ligament	Vertebrate

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Skelton, John (1460?-1529), was a great satirist during the early part of the reign of the House of Tudor in England. Skelton lived at court and tutored Henry VIII, then a young prince. Skelton became a priest in 1498 and served as rector of Diss in Norfolk. There he wrote *Ware the Hawk,* a savage satire on a priest who preferred hunting with falcons to religion; and *Philip Sparrow,* a playful elegy about a young girl's dead pet bird. About 1520, Skelton wrote three poems that satirize the church and Cardinal Wolsey—*Colin Clout, Why Come Ye Not to Court?,* and *Speak, Parrot.* Skelton wrote much poetry in blocks of short, irregular, consecutively rhymed lines, later called *Skeltonic meter.* Skelton was probably born in Norfolk. John N. King

Skepticism was a philosophical movement in ancient Greece. Skeptics tried to weaken people's confidence in observation and reason as trustworthy guides to understanding the world, and they argued against all dogmatic schools of philosophy. They believed that people can be certain of the nature of their observations but cannot be sure that their observations reflect the real world. According to the Skeptics, people must suspend judgment regarding the truth or falsity of their perceptions.

There were two main schools of Skepticism in ancient Greece. The first school regarded Pyrrho of Elis, who lived from about 361 to 270 B.C., as its founder, and was called *Pyrrhonian Skepticism.* It was developed by Anesidemus and is presented most fully in the writings of Sextus Empiricus, who lived about A.D. 200. The goal of this school was a tranquility of life that follows from suspending judgment.

The second school of Skepticism was developed in the school of philosophy founded by Plato and was known as *academic Skepticism.* This school was begun by Arcesilaus in the 200's B.C., and it was continued by Carneades in the 100's B.C. These Skeptics were concerned with revealing the difficulties of other philosophers' points of view. Summaries of these Skeptic doctrines are preserved in Cicero's *Academica.*

Carl A. Huffman

See also Carneades; Pyrrho of Elis.

Sketching. See Drawing.

Skew line, in advanced geometry, is a line in space that neither runs parallel to another line nor intersects another line. The word *skew* means *slanting* or *indirect.*

In statistics, a normal distribution has a mound-shaped curve. A curve is called *skewed* if it tapers off to the right or left of a mound-shaped distribution curve.

Photri

Downhill skiing is the most popular form of skiing. Highly skilled downhill skiers can race down steep mountain slopes at speeds of about 60 miles (97 kilometers) per hour.

Peter Miller

Cross-country skiing is hiking on skis over snow-covered ground that is flat or slightly hilly. This activity is easy to learn, but it requires much physical endurance.

Skiing

Skiing is the act of gliding over snow on long, narrow runners called *skis.* Many skiers enjoy the thrill of speeding down mountain slopes. Others like the challenge of traveling long distances across flat or slightly hilly terrain. Skiing is an extremely popular form of entertainment. It is also a major competitive sport.

Types of skiing

There are three types of skiing: (1) Alpine skiing, (2) Nordic skiing, and (3) freestyle skiing. Closely related to skiing is a relatively new activity called *snowboarding.* The two most popular and basic forms of skiing are *Alpine skiing* and *cross-country skiing,* a form of Nordic skiing. The following discussion describes the basic techniques of each type. For information on Alpine and freestyle skiing competition, see the section *Skiing as a sport.* For information on snowboarding, see the **Snowboarding** article.

Alpine skiing refers to skiing downhill. It is popular as a form of recreation and as a competitive sport. The term *Alpine* comes from *Alps,* the name of the mountain system in Europe where downhill skiing originated.

Alpine skiing involves many techniques and maneuvers. However, the three basic maneuvers of downhill skiing are (1) schussing, (2) traversing, and (3) turning. Skiers carry a ski pole in each hand to help them keep their balance while making these maneuvers. The poles also aid skiers in walking and climbing.

Schussing is skiing straight down a slope without turning or stopping. It is the fastest form of skiing because skiers follow the *fall line*—that is, the most direct route to the bottom of the slope.

Traversing is skiing at an angle to the fall line. Skiers use this maneuver to control their speed. They *edge* their skis while traversing to avoid slipping downhill sideways. Edging is done by tilting the skis at an angle to the slope so their metal edges bite into the snow.

Turning is the most difficult part of downhill skiing. Turning enables skiers to change directions, control their speed, and avoid obstacles. The most elementary turn is the *wedge,* also called the *snowplow,* in which the skis are placed in a V position with tips nearly touching and edged slightly inward. The wedge turn is also used to stop. A more complex turn is the *stem.* In this turn, the skis are first placed in a modified V position and are brought to a parallel position later in the turn. The *carved parallel* is the most advanced and difficult turn. In the carved parallel turn, the skier quickly and smoothly turns both skis in the same direction at virtually the same moment.

To halt their downhill progress, skiers make a sharp turn perpendicular to the hill and let the edges of the skis chatter across the snow. This maneuver is called a *hockey stop* or *skate stop* because it is similar to the way ice skaters stop.

Nordic skiing consists of (1) cross-country skiing and (2) ski jumping. The term *Nordic* refers to northern Europe—especially Norway, Sweden, and Finland—where cross-country skiing first developed as a practical means of travel in winter.

Cross-country skiing is the most popular form of Nordic skiing, both as recreation and as a competitive sport. Cross-country skiers glide across snow-covered terrain that is flat or slightly hilly. The basic movement is the *diagonal stride.* This movement resembles jogging on skis. The skier leans slightly over the front of the skis and moves one ski forward, putting pressure on it to provide a platform for shifting weight onto the other ski as it comes forward. The maneuver with the first ski is called the *kick,* and that with the other one is called the *glide.* The pole in the hand opposite the kick ski is set in

Focus on Sports

Ski jumping demands a high level of skill and concentration as well as strength, grace, and courage. In championship competition, ski jumpers may leap more than 300 feet (91 meters).

the snow and pushed backward to further propel the skier forward.

The *skate* is another movement in cross-country skiing. In the skate, one ski glides forward in a straight line, while the other is kicked out sideways and back in a skating motion to provide greater forward thrust.

To climb extremely steep hills, cross-country skiers often use a movement called a *herringbone,* the reverse of an Alpine skier's wedge. In a herringbone, the cross-country skier spreads the tips of the skis far apart and takes choppy little steps.

Ski jumping is a highly specialized form of skiing in which a skier slides down a steep track and flies off a platform at the end. Jumpers are evaluated on the distance of their leap and on their jumping style. Both portions count almost equally. Most ski jumping is performed on specially constructed 90-meter and 120-meter (295-foot and 395-foot) hills. The measurements refer to the typical distance a skilled jumper will fly from the take-off lip to landing. Larger 180-meter (590-foot) hills are called *ski flying hills.* They are not used in major international competition.

Freestyle skiing is a form of skiing in which skiers perform stunts. There are three types of freestyle skiing: (1) aerial, (2) mogul or bump, and (3) acrobatic.

Aerial, the most dramatic type of freestyle skiing, resembles diving performed on skis. Aerial skiers ski down a steep hill and leap off a sharp platform, performing spins, flips, and other maneuvers before landing. They are judged both on the difficulty of the stunt performed and on how well they execute it.

Mogul or bump freestyle skiing takes place on a steep slope with many *moguls* (moundlike elevations). Skiers try to ski quickly down the slope while performing small jumps and acrobatic maneuvers.

Acrobatic, or ***acro,*** freestyle skiing combines movements used in figure skating and gymnastics. Skiing to music they select, competitors perform spins, pirouettes, rolls, somersaults, and other maneuvers.

Ski equipment and clothing

Standard ski equipment consists of (1) skis, (2) ski poles, (3) ski boots, and (4) ski bindings. Skiers also wear special clothing for warmth and comfort.

The equipment differs somewhat for Alpine and Nordic skiing and for recreational and competitive skiing. Using the proper equipment and maintaining it in top condition helps skiers perform better and also reduces the chance of injury.

Skis are narrow runners that curve up at the *tip* (front end). The center part of the ski is called the *midbody.* The back end is called the *tail.* The midbody is arched above the tip and tail to make turning easier.

Skis can be made of a variety of materials, including fiberglass, plastic, metal, polyurethane foam, Kevlar, and wood. Alpine and freestyle skis are constructed in a similar way and have metal edges along both sides to make turning easier. Cross-country skis are narrower and lighter than Alpine and racing skis, and have no metal edges. Jumping skis are the longest and heaviest skis, usually measuring 94 inches (240 centimeters) in length.

Since the mid-1990's, a new ski design has made a major impact on Alpine skiing, especially among recreational skiers of beginning or average skills. The new design is called *shaped, parabolic,* or *side-cut.* Unlike the traditional ski, the shaped ski is much broader at the nose, narrow at the midbody, and much wider at the tail. It is also almost 4 to 8 inches (10 to 20 centimeters) shorter than the traditional ski design.

The new shaped design allows skiers to make smooth turns at low speeds with comparatively little effort. The long tapered shape keeps the ski's edges in contact with the snow while the skier turns, providing more control. The skier can also change direction more easily, with only a slight turn of the ankles or shift of the weight from one ski to the other.

The shaped ski has helped beginning and intermediate skiers exercise greater control over changes of direction and speed. It also provides these skiers with more confidence. Beginners learn faster, and more advanced skiers can ski on steeper slopes and in more difficult snow conditions than they may have attempted with traditional skis.

In most cases, the taller, heavier, and more skillful a skier is, the longer the skis should be. Most Alpine skis are manufactured in France, Austria, Switzerland, and Italy. Cross-country skis are made in these countries, as

Terms used in skiing

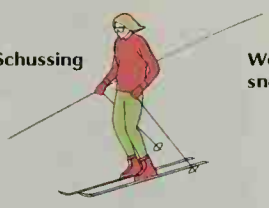
Fall line is the most direct route to the bottom of a slope.
Mogul refers to a bump in the terrain. Most moguls are formed by many skiers turning in the same place and pushing the snow into a mound.
Parallel turn is a turn in which the skis are kept parallel and close together throughout the turn.
Schussing is skiing straight down the fall line without turning or stopping.
Stem is the initial movement in steered turns in which the back of the ski closer to the top of the slope is pushed out.
Traversing means skiing across a slope at an angle to the fall line.

Basic skiing techniques

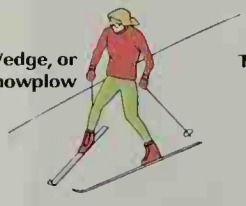
A person must master certain basic techniques to become a skilled downhill or cross-country skier. These diagrams illustrate some of the maneuvers beginning skiers have to learn.

WORLD BOOK illustrations by David Cunningham

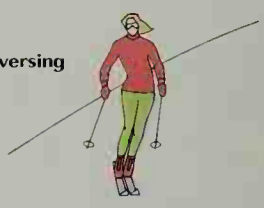
Downhill techniques



Schussing is the fastest technique. The skier bends at the ankles, knees, and hips and follows the *fall line* (direct route down the slope).



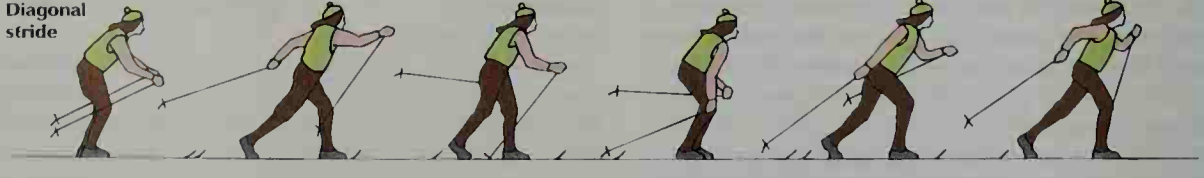
The wedge, or snowplow, is the basic method of turning, slowing, or stopping. The skier pushes the ski tails out, bringing the tips together.



Traversing is skiing at an angle to the fall line. The lower part of the skier's body is tilted toward the slope, so the skis' edges grip the snow.

Turns are the most difficult skiing maneuvers. Skiers often first learn the wedge, or snowplow, turn. It is begun in the wedge position and completed by putting weight on only one ski. To perform the carved parallel, skiers must shift their weight to turn both skis together.

Cross-country techniques



The diagonal stride is the basic movement in cross-country skiing. This diagram shows how the skier alternately moves one ski forward, while gliding on the other. As the ski moves forward, the skier brings the arm on the opposite side forward and plants the pole for speed and balance.

Skate stride

The skate stride enables the skier to pick up speed. The skier glides forward on one ski, while kicking out the other ski sideways and back in a skating motion. The skier plants both poles at the same time to help provide thrust.

well as in Norway, Sweden, and Finland.

Ski poles are made of aluminum or composite materials. The shaft usually tapers from the top to a point at the bottom. A round or star-shaped piece of plastic called a *basket* is mounted about 3 inches (8 centimeters) from the point and prevents the pole from sinking too deeply into soft snow. Skiers hold each pole at the *grip,* a rubber or plastic handle at the top of the pole. The grip can be shaped like a sword handle or have a strap that fits around the skier's hand to prevent it from being dropped unintentionally and provide leverage when pushing across flat terrain. Poles for Alpine skiing should reach slightly above the skier's waist. Freestyle acro skiers use longer, thicker, and stronger poles because the pole must support the skier's weight during somersaults. Cross-country poles resemble Alpine poles, but they are longer and their point is set at an angle to the shaft. The point grips the snow when the pole is swung forward and slips out of the snow easily when the skier glides beyond the pole.

Ski boots provide support and warmth for the skier's feet. Alpine boots consist of an outer *shell* made of rigid plastic and an *inner boot* made of a combination of foam, leather, vinyl, or other materials. They are generally fastened by buckles that run across the calf, instep, and forefoot. They sometimes have devices for adjusting flex resistance that also permits easier walking. All toes and heels on Alpine ski boots are identical in shape so they can be used in any binding.

Freestyle skiers use Alpine boots. Cross-country boots are much lower in height and are more pliable to permit the foot to flex at the forefoot.

Ski bindings are springlike devices screwed to skis to hold the boots firmly to the skis. If a skier falls, the bindings release the boot from the ski and thus help prevent leg injuries. Alpine bindings secure the boot at both the toe and heel. They use a complex system of springs, cam rollers, and levers to ensure that skiers do not separate from their skis, except when injury might occur. Ski bindings also include *ski brakes,* which act by forcing two prongs into the snow when a skier releases a binding. The brake prevents a released ski from speeding down the slope and hitting other skiers.

Bindings on cross-country skis secure the boot only at the toe, keeping the heel free to lift during the kick phase of the diagonal stride. Many cross-country bindings also have a *ridge plate* behind the toe piece. The ridge plate fits into a groove in the sole of the boot to keep the skier's foot from slipping off the ski.

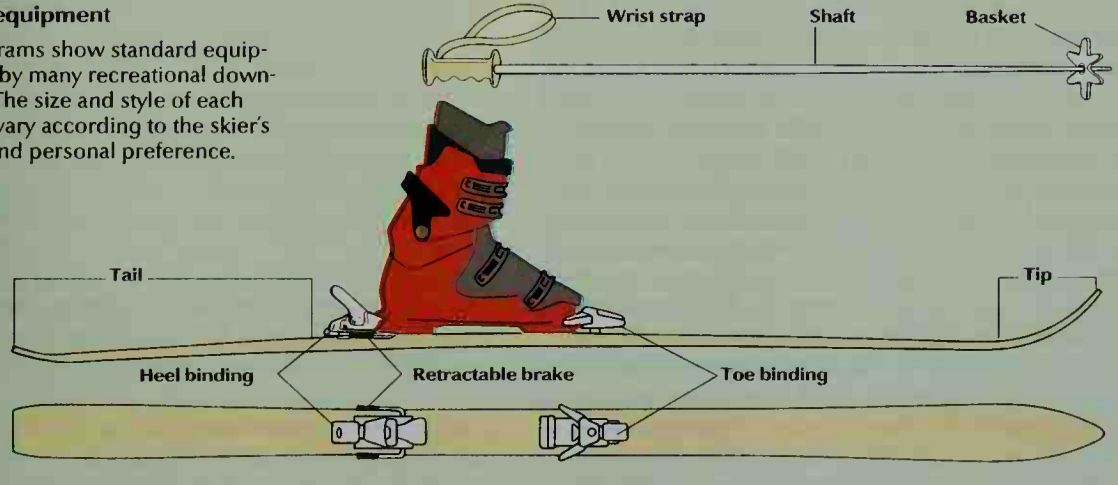
Ski clothing is specially constructed to be extremely warm and waterproof. It should also fit snugly without restricting movement. Elasticized waist and cuff bands, snaps, and hook-and-loop fasteners help keep snow from getting inside clothing. Most skiers dress in layers to create air pockets that trap heat. Alpine skiers generally wear warmer, heavier clothing than cross-country skiers because they produce less body heat while skiing. Alpine skiers normally wear thermal underwear, a turtleneck sweater, a parka, insulated ski pants, waterproof gloves, a hat, and one pair of medium-weight socks. Cross-country skiers dress in similar clothing but wear looser pants and tops that allow greater movement. In addition, cross-country skiers wear clothes that can be removed easily as they generate body heat. Both

Ski equipment

WORLD BOOK diagrams by Zorica Dabich

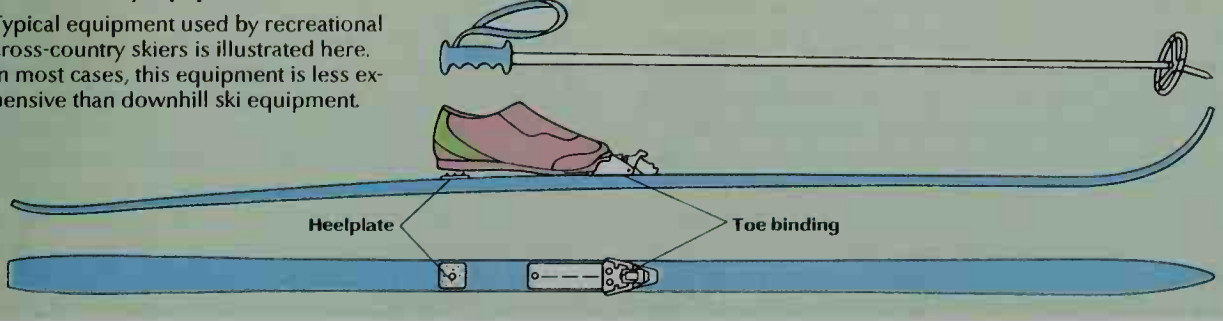
Downhill equipment

These diagrams show standard equipment used by many recreational downhill skiers. The size and style of each piece may vary according to the skier's size, skill, and personal preference.



Cross-country equipment

Typical equipment used by recreational cross-country skiers is illustrated here. In most cases, this equipment is less expensive than downhill ski equipment.



Alpine and cross-country skiers wear goggles or sunglasses. In the late 1990's, many skiers, especially children, began wearing safety helmets.

Skiing as recreation

Skiing is an extremely popular form of recreation in many countries. Over 15 million Americans and Canadians enjoy some form of skiing. Skiing is also popular in many European countries, Japan, Argentina, Chile, New Zealand, and Australia.

Ski area facilities. There are thousands of Alpine ski areas in the world. Most of these areas are in Europe, the United States, Japan, and Canada. Colorado is the most popular state for skiing in the United States, though New York has the most ski areas. Popular U.S. ski areas include Aspen and Vail, Colorado; Mammoth Mountain and Squaw Valley, California; and Killington and Mount Snow, Vermont. In Canada, popular areas include Banff, Alberta; Whistler, British Columbia; and Tremblant and Mount Ste. Anne, Quebec. Europe has some of the world's most luxurious and famous ski areas, including St. Moritz, Switzerland; Innsbruck, Austria; and Val d'Isère, France.

Most ski areas provide ski instruction and food and lodging services, and have shops that rent and sell ski and snowboarding equipment. Ski areas are usually located in hilly or mountainous regions with heavy snowfall. However, *snowmaking machines* make skiing possible in areas with light snowfall. Almost every ski area in the United States has these machines.

Many people enjoy cross-country skiing in parks, open fields, and other flat or somewhat hilly areas. In addition, many Alpine ski regions have paths for cross-country skiing called *touring centers.*

Ski trails range from smooth, wide, gentle slopes for beginners, to steep, narrow chutes that challenge experts. Some trails, especially those in the eastern United States, wander through wooded hillsides that require clearing before they become skiable. In Europe and South America, many slopes are located above the altitude at which trees stop growing. These trails permit skiers to wander across vast areas.

Skiers should choose trails suited to their ability and should not ski alone. Many major ski areas hire professional *ski patrollers* to aid injured skiers and enforce ski safety rules. At other areas, these functions are handled by volunteer members of the National Ski Patrol System.

All Alpine ski areas have *ski lifts.* These devices transport skiers to the top of a slope. They use a rope or braided metal cable attached to a motor-driven pulley to carry skiers uphill by chair lift, tram, or gondola. *Surface lifts* move skiers uphill on the snow surface.

Snow conditions on trails vary greatly, depending on the weather, the ski area's location, and the time of year. Some areas, such as those in the Rocky Mountains, generally receive light, dry snow called *powder,* which is ideal for skiing. *Corn snow* is tiny pebblelike snow that occurs most often in spring. *Packed powder* and *machine-groomed* are the most common snow conditions. They result from skiers repeatedly passing over freshly fallen snow, or from snow being churned and compressed by tanklike *grooming machines.*

Ski instruction shortens the learning period for beginners and adds to the safety and enjoyment of skiing.

Photri

The giant slalom is a main event in most Alpine, or downhill, skiing competitions. Competitors traverse at high speeds and make sharp turns as they race through a series of gates.

Experienced skiers often take lessons to improve their skills. All major U.S. ski areas have ski schools.

Most Alpine ski schools use the American Teaching Method (ATM). This method was developed by the Professional Ski Instructors of America (PSIA), the licensing body for U.S. ski instructors.

Beginners generally start on shorter skis. They first learn how to walk on skis and then how to get up from a fall. Then they learn sidestepping uphill, traversing across a hill, schussing a short slope, and simple turns, such as the wedge. Later, they learn more difficult turns.

Skiing as a sport

The World Cup is the most important amateur skiing championship. World Cup titles are awarded each year to the men and women who have won the most points in a series of races. The competitions are held in various Northern Hemisphere countries from December to March.

Other major amateur competitions include the Alpine, Nordic, and freestyle events of the World Ski Championships and the Winter Olympic Games. The World Ski Championships are held every odd-numbered year. The Olympics are held every fourth year. The Fédération Internationale de Ski (FIS) governs all international amateur skiing competitions and also sponsors the World Ski Championships. United States Skiing governs all U.S. amateur ski competitions.

Professional skiing races take place throughout the world, but they are not generally of as high a caliber as the amateur competitions. Both amateur and professional skiers can earn prize money. Most top skiers also earn money from ski equipment and clothing manufacturers and other companies that sponsor them, based on how well they finish.

Alpine competitions. Most Alpine competitions are made up of one or more of five kinds of races: (1) the downhill; (2) the slalom (pronounced *SLAH luhm);* (3) the

giant slalom; (4) the super G; and (5) the parallel slalom. In the downhill, slalom, giant slalom, and super G, skiers race one at a time. In the parallel slalom, two skiers race at the same time on identical courses side-by-side. Skiers make two runs down similar courses in the slalom, giant slalom, and parallel slalom. In the downhill and super G, skiers make only one run.

The following discussion describes the races as conducted under FIS regulations, which most amateur competitions follow.

The downhill race is a test of high-speed skiing. It is run on a course with a vertical drop of 800 to 1,000 meters for men's events and 400 to 700 meters for women's. As a safety measure, *control gates* are placed along the course. They direct skiers away from dangerous areas and force them to reduce their speed. Each gate consists of two flags that the competitors must ski between. Skilled downhill racers average 65 to 70 miles (105 to 113 kilometers) per hour and can complete the course in 1 $\frac{1}{2}$ to 2 minutes.

The slalom challenges skill in high-speed turning. The course is marked by numbered gates that each competitor must pass through in proper order. The gates are set so that the racers must make many turns, skiing in a zigzag fashion.

The giant slalom is a test of high-speed traversing. It combines elements of both the downhill race and the slalom.

The super G, formerly called the *super giant slalom,* is a cross between the downhill race and the giant slalom.

The parallel slalom has two or more courses that resemble a small slalom course. The courses are from 6 to 7 meters apart. Most professional races are parallel slaloms or parallel giant slaloms.

Combined competitions consist of a downhill race and a slalom. The two events are always held in the same location but often take place on different days.

Other types of competition. During the late 1990's, several new professional types of competition were introduced using Alpine skis. In *extreme* or *freeskiing* events, skiers soar down exceptionally steep and rocky courses one at a time. Contestants are judged on elapsed time and the skill and daring they exhibit during runs. *Skier-cross* begins with a mass start down a slope with bumping and jostling permitted during tight parts of the course. The first racer to cross the finish line wins.

Nordic competitions consist of five events. They are (1) cross-country races, (2) cross-country relays, (3) jumping competitions, (4) the Nordic combined, and (5) the biathlon.

Cross-country races are conducted on courses that are about one-third uphill, one-third downhill, and one-third flat. In classical races, only the diagonal stride is permitted. In freestyle events, the faster skate stride may be used. In major meets, the men's cross-country courses are 10, 15, and 30 kilometers long. Women's courses are 5, 10, 15, and 30 kilometers. The skier with the fastest time wins.

Cross-country relays are team competitions in which each member of the team races an equal distance. For example, teams of four compete in the 40-kilometer men's relay in the Winter Olympics, and each member skis 10 kilometers. The first skiers from each team start at the same time.

Jumping competitions are popular spectator events in competitive skiing. Competitors receive points for both the length of their jump and their jumping style. The skier with the most points wins. A jumper may outdistance the other competitors but lose the event because of a shaky landing or some other flaw in style. Jumpers may fly more than 300 feet (91 meters).

The Nordic combined consists of both cross-country skiing and ski jumping. Competitors race over a 15-kilometer course and make three ski jumps. They receive points for each activity, and the skier with the most points wins the event.

The biathlon combines cross-country racing and riflery. In most individual competitions, participants ski over a course 10 or 20 kilometers long on which targets are set at different points. The skiers must shoot at the targets from the standing and *prone* (lying down) positions and are penalized for every miss. The skier who completes the course in the shortest time wins. In the biathlon relay, four skiers each race 7.5 kilometers.

History

Skiing began thousands of years ago in northern Europe and Asia. Norwegian immigrants introduced skiing into the United States in the mid-1800's.

The development of modern skiing began about 1850, when a Norwegian named Sondre Norheim invented the first stiff bindings. The bindings held the skis more securely than leather straps did and so provided greater control. With his improved bindings, Norheim developed new turning maneuvers.

In 1896, Mathias Zdarsky of Austria introduced the technique of pushing one ski at an angle to the fall line to control speed. During the early 1900's, Hannes Schneider, who lived in the Arlberg region of Austria, developed new stopping and turning maneuvers based on Zdarsky's technique. Schneider organized these maneuvers into the first formal method of ski instruction. It became known as the *Arlberg* technique and forms the basis of most modern skiing techniques.

During the early 1900's, skiing became an increasingly popular competitive sport. Switzerland held the first organized slalom race in 1921. In 1924, Nordic competitions were included in the first Winter Olympic Games. The competitions now called the World Ski Championships began in 1925. In 1936, Alpine events became part of the Winter Olympics.

The invention of ski lifts during the early 1930's led more and more people to take up recreational skiing. To accommodate the increasing number of skiers, many ski areas and resorts were expanded or developed in the United States, Canada, and Europe.

The middle and late 1900's. Early in World War II (1939-1945), Finland used ski patrols to resist Soviet invaders. In 1945, U.S. Army 10th Mountain Division ski troops fought a decisive battle with German forces in the mountains of Italy.

After the war, skiing began a new boom. Winners of international meets attracted increasing publicity. In 1948, Gretchen Fraser became the first American to win an Olympic gold medal for skiing. The big star of the 1950's was Toni Sailer of Austria—winner of three gold medals in the 1956 Olympics. The superstar of the 1960's was France's Jean-Claude Killy. He won the World Cup in

1967 and 1968 and three gold medals in the 1968 Olympics.

The publicity given skiing champions and the coverage of ski meets on television and in the press stimulated interest in recreational skiing. During the 1960's, about 400 ski resorts were built in the United States.

Ingemar Stenmark of Sweden dominated skiing throughout much of the 1970's and 1980's. He finished his career with a record 86 World Cup victories. Annemarie Moser-Proell ranks as the top female World Cup skier with 62 victories. Alberto Tomba of Italy was the top Alpine skier from the mid-1980's to the late 1990's.

Picabo Street became the most successful U.S. female skier of the 1990's, winning medals in the 1994 and 1998 Winter Olympic Games. Bjorn Daehlie of Norway, who began skiing in the late 1980's, ranks as the most successful cross-country skier in history. Daehlie won more than 40 World Cup races and a record eight gold medals in the Winter Olympics.

Skiing today. The Alpine World Cup remains the leading skiing competition. It has been dominated by an Austrian team led by Hermann Maier. The major Nordic teams come from such traditionally strong countries as Norway, Russia, and Sweden. Americans have dominated freestyle skiing.

While skiing remains a popular sport in Europe and North America, the number of recreational participants has not risen since the mid-1980's. Few new ski areas have been built since the early 1980's, due to the cost of construction and to opposition from antigrowth groups. Many small ski areas have closed, unable to afford the large expense for state-of-the-art ski lifts and snowmaking and grooming equipment. Many large ski areas, however, have doubled and tripled in size. Most of the largest North American ski areas are now owned by a few corporations. Steve Cohen

Related articles in *World Book* include:

Biathlon
Canada (picture)
Chile (picture)
Michigan (Places to visit)
Olympic Games (The Winter Games; table)
Snowboarding
Switzerland (picture)
Sweden (picture)
Vermont (picture)
Water-skiing
West Virginia (picture)

Outline

I. Types of skiing
- A. Alpine skiing
- B. Nordic skiing
- C. Freestyle skiing

II. Ski equipment and clothing
- A. Skis
- B. Ski poles
- C. Ski boots
- D. Ski bindings
- E. Ski clothing

III. Skiing as recreation
- A. Ski area facilities
- B. Ski trails
- C. Ski instruction

IV. Skiing as a sport
- A. Alpine competitions
- B. Nordic competitions

V. History

Questions

What are the three types of freestyle skiing?
How does a skier avoid sliding sideways while traversing?
What is the Nordic combined? The biathlon?
What is a *herringbone?*
What is the *fall line?*
When are the World Ski Championships held?
What is *corn snow? Powder?*
Who was Hannes Schneider?
Why is schussing the fastest form of skiing?
Why do skiers wear sunglasses or goggles?

Additional resources

Allen, E. John B. *From Skisport to Skiing: One Hundred Years of an American Sport, 1840-1940.* Univ. of Mass Pr., 1993.
Brimner, Larry D. *Skiing.* Children's Pr., 1997. Snowboarding. Watts, 1997. Both for younger readers.
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Skimmer is the name for three species of birds that live near oceans, lakes, and other bodies of water. The name *skimmer* comes from the way the birds fly rapidly along the surface of the water. A skimmer holds its beak open and keeps the lower part beneath the surface, scooping up insects, small fish, shrimp, and other small animals. Skimmers are also called *scissorbills* because of their thin, bladelike bills. The lower part of the bill is much longer than the upper part.

The *black skimmer,* found in North America and South America, has black feathers on its upper body and white feathers on the underside. The female black skimmer makes its nest in a hollow in the sand. It lays three to five eggs. The *African skimmer* lives in Africa, and the *Indian skimmer* lives in Asia. Peter G. Connors

Scientific classification. Skimmers make up the skimmer family, Rynchopidae. The black skimmer is *Rynchops niger.*

See also **Bird** (pictures: Birds of the seacoasts; How birds feed).

Skin is the organ that covers the bodies of human beings and many other animals. In human beings, the skin protects the body in a wide variety of ways. For example, the skin is almost completely waterproof and so prevents the escape of the fluids that bathe body tissues. It also prevents bacteria and chemicals from entering most parts of the body and is an important part of the body's defense against disease. The skin protects underlying tissues from harmful rays of the sun.

The skin also helps keep the body's internal temperature normal. Glands in the skin release sweat when a person becomes overheated. The sweat evaporates and so cools the body. When a person becomes too cool, the body retains heat by narrowing the blood vessels in the skin. As a result, the flow of blood near the surface of the body decreases, and the body gives off less heat. The skin has many nerve endings that are sensitive to cold and heat, as well as pain, pressure, and touch.

The skin is the largest organ of the human body. If the skin of a 150-pound (68-kilogram) adult male were spread out flat, it would cover about 20 square feet (1.8 square meters).

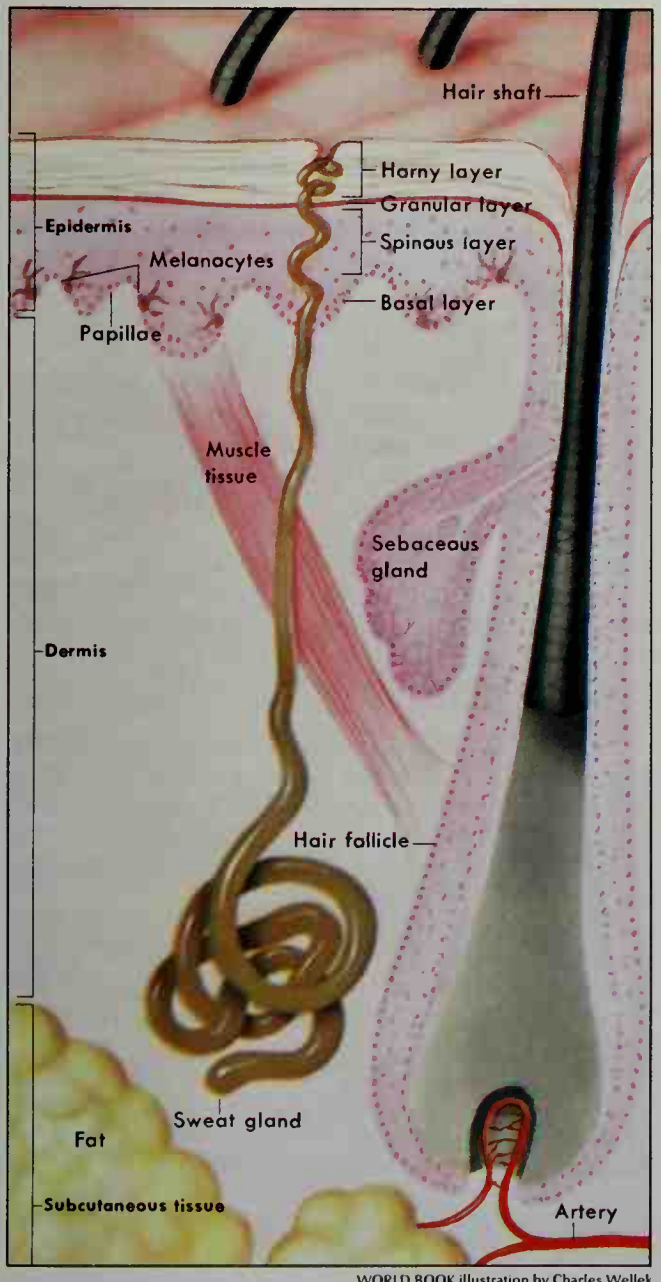
This article deals mainly with the skin of human beings. It discusses the structure and color of the skin and various skin disorders. The last section describes the skin of other animals.

Structure of the skin

The skin has three layers of tissue: (1) epidermis, (2) dermis, and (3) subcutaneous tissue. The epidermis, the outermost layer, is about as thick as a sheet of paper over most parts of the body. The dermis, the middle layer, is between 15 and 40 times as thick as the epidermis. The subcutaneous tissue, the innermost layer, varies greatly in thickness among individuals. In all people, however, the subcutaneous tissue is much thicker than

the epidermis and dermis. In addition to these tissues, the skin includes the hair, nails, and certain kinds of glands.

Epidermis has four layers of cells. From the outermost to the innermost, they are the *horny, granular, spinous,* and *basal layers.* The horny layer consists of between about 15 and 40 rows of dying cells. These cells are filled with a tough, waterproof protein called *keratin.* The granular layer consists of one or two rows of dying cells that contain small grains of a substance called *keratohyaline.* The spinous layer is composed of between about 4 and 10 rows of living cells that have spinelike projections where the cells touch one another. The basal layer is also made up of living cells. It consists mainly of a single row of tall, narrow *basal cells.* The basal layer also includes cells called *melanocytes.* These cells produce a brown pigment called *melanin.*



WORLD BOOK illustration by Charles Wellek

Human skin has three layers of tissue—the *epidermis,* the *dermis,* and *subcutaneous tissue.* The epidermis consists of four layers of cells—*horny, granular, spinous,* and *basal.* The skin also has hair and two kinds of glands, *sebaceous* and *sweat.*

The basal cells divide continually and form *daughter cells.* Some daughter cells remain in the basal layer. Others move toward the outer surface of the skin and eventually form the upper layers of the epidermis. These cells are called *keratinocytes,* and they produce keratin. Keratin is found only in the epidermis, hair, and nails. Keratin makes the skin tough. It also prevents fluids and certain substances from passing through the skin. As the keratinocytes move upward through the epidermis, they become filled with more and more keratin. By the time they reach the surface of the skin, they have died and become flat and dry. Eventually, they are shed as thin flakes.

Dermis is made up chiefly of blood vessels, nerve endings, and connective tissue. The blood vessels nourish both the dermis and the epidermis. The surface of the dermis has many tiny elevations called *papillae* that fit into pits on the undersurface of the epidermis. They help connect the dermis to the epidermis. The papillae contain nerve endings that are sensitive to touch. The nerve endings are especially numerous on the palms and fingertips.

Subcutaneous tissue consists mainly of connective tissue, blood vessels, and cells that store fat. The subcutaneous tissue helps protect the body from blows and other kinds of injuries. It also helps retain body heat. The amount of fat in the subcutaneous tissue may increase after a person overeats. If the body needs extra food energy, it breaks down this stored fat.

Hair, nails, and glands. Hair, nails, and the glands in the skin are called *epidermal appendages.* They are formed from the basal cells of the epidermis.

Hair. Most of the skin is covered by tiny hairs. The scalp and some other parts of the body have large hairs. The palms of the hands and the soles of the feet have no hair at all. Part of each hair extends below the surface of the skin. This part lies in a baglike structure called the *follicle.* The end of the hair, called the *bulb,* is the only living part of a hair. It lies in the dermis or subcutaneous tissue. The cells of the bulb divide rapidly and account for the growth of a hair. The hair cells above the bulb contain a form of keratin called *hard keratin.*

Nails. A nail has three parts, the *matrix, plate,* and *bed.* The matrix lies under the surface of the skin at the base of the nail. Most of the matrix is covered by skin. But part of the matrix forms a whitish half moon that can be seen at the base of the nail. The plate is the hard outer part of the nail. It consists of many layers of flat, dead cells that contain keratin. The bed lies under the plate. The cells of the bed and plate are formed in the matrix. Newly formed cells push the older ones toward the tip of the nail. This pushing process results in the growth of the nail.

Glands. The skin has two kinds of glands, *sebaceous* and *sweat.* Sebaceous glands empty into hair follicles. These glands secrete an oil called *sebum,* which lubricates the hair and the surface of the skin.

There are two types of sweat glands, *eccrine* and *apocrine.* Eccrine glands produce the sweat that cools the body. They are located throughout the surface of the skin but are particularly numerous on the forehead, palms, and soles. Some eccrine glands produce secretions continually. Others become active only when a

person is under physical or emotional stress. Eccrine glands release their secretions onto the surface of the skin. Apocrine glands produce sweat that has no important function. Most of these glands are in the armpits and around the *genitals* (external sex organs). They release their secretions into hair follicles.

Sweat is odorless until after it has been broken down by bacteria on the surface of the skin. After this process occurs, sweat has what many people consider an unpleasant odor. Apocrine sweat smells stronger than eccrine sweat, and so the armpits and genital area are the chief sources of body odor.

Skin color

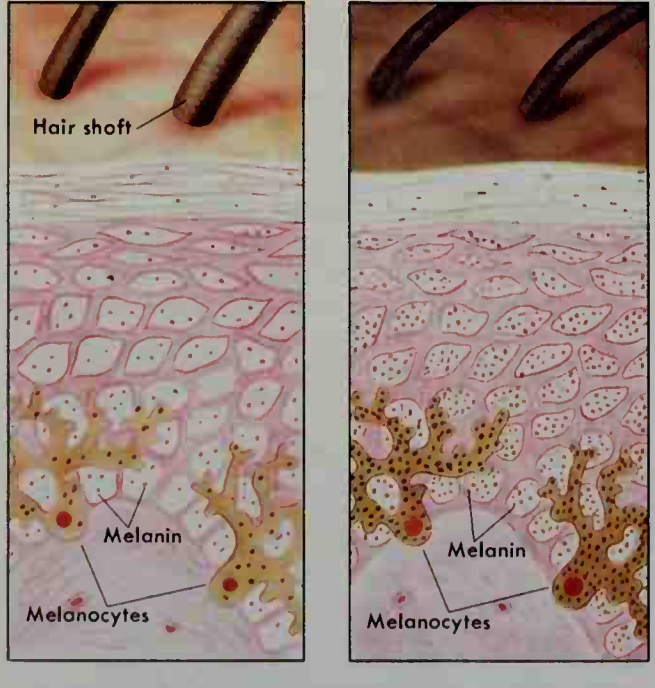
The color of the skin varies greatly among population groups and individuals. Skin color depends mainly on the amount of the brown pigment melanin produced in the skin. Melanin is formed by the melanocytes in the epidermis. All people have about the same number of melanocytes. However, the melanocytes of dark-skinned people produce more melanin than do those of light-skinned people. The amount of melanin produced in each person's skin is determined mainly by heredity. However, exposure to sunlight increases the production of melanin, causing light skin to tan. In some cases, melanin builds up in small spots, forming freckles. Most freckles appear on the face and hands. Exposure to sunlight may increase freckling.

As a person grows older, the melanocytes produce melanin at uneven rates, which causes some areas of the skin to remain light and others to darken. These dark spots are sometimes called *age spots* or *liver spots*. As a person ages, the skin also becomes thinner and drier and so starts to wrinkle and turn scaly. In addition, the skin of an old person bruises and chaps more easily and heals more slowly.

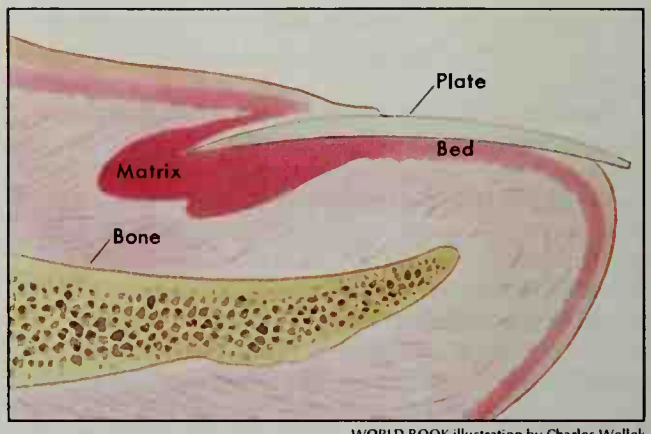
Skin color

Skin color depends mainly on the amount of brown pigment, called *melanin,* in the skin. In light skin, *below left,* cells known as *melanocytes* produce a small amount of melanin. In dark skin, *below right,* these cells produce more melanin.

WORLD BOOK illustrations by Charles Wellek



Light skin Dark skin



WORLD BOOK illustration by Charles Wellek

The nails of the fingers and toes are formed from certain cells of the skin. A nail has three parts—the *matrix, bed,* and *plate.* The matrix produces the cells of the bed and plate.

Skin disorders

Inflammation of the skin is called *dermatitis.* The most common form of dermatitis is *eczema,* in which the skin itches and becomes red. The skin may be crusty, or fluid may ooze from it. *Atopic eczema* is common in children. In most cases, it appears on the face, back of the neck or knees, or inner side of the arms. *Contact dermatitis* is an allergic reaction to certain substances that a person touches. For example, many people develop itchy blisters after touching poison ivy.

Infections of the skin are caused by bacteria, fungi, parasites, or viruses. Some of these organisms invade the body in areas where the skin has been broken open. Others remain on the surface of the skin.

Bacteria cause such infections as *boils* and *impetigo.* Boils are painful, red lumps filled with pus. Impetigo, which chiefly afflicts children, causes thin blisters to erupt on the skin. The blisters break, and the skin becomes crusty.

Fungi cause such infections as *ringworm* and *athlete's foot.* Ringworm is a general name for several kinds of fungal infections. Common ringworm is characterized by patches of red, scaly, ring-shaped spots. Athlete's foot is a type of fungal infection in which cracks form in the skin between the toes.

Parasites that infect the skin include *lice* and *scabies mites.* Lice infest the hair of the scalp and of other parts of the body. Scabies mites burrow under the surface of the skin. Both lice and scabies mites cause the skin to itch and are contagious.

Viruses cause *cold sores, shingles,* and other kinds of infections. Cold sores are blisters that usually appear around the mouth. Shingles are painful blisters that occur primarily on the chest and lower back.

Burns may be caused by heat from fire or other sources or by chemicals, electric shock, or overexposure to sunlight.

Physicians classify the injuries as *first-degree, second-degree,* and *third-degree* burns. First-degree burns cause the skin to turn red. These burns affect only the epidermis, and they heal without leaving scars. Second-

degree burns cause the skin to blister. They affect the epidermis and part of the dermis and may leave slight scars. Third-degree burns cause the skin to blister or turn black. They damage all three layers of the skin. Some victims require surgery to remove dead tissue and repair the skin. The surgeon may perform a *skin graft,* in which the damaged tissue is replaced with healthy skin (see Skin grafting).

Sunburns may be mild or severe. Mild sunburn causes the skin to turn red, but the redness disappears in a few hours or days. Severe sunburn produces blistered skin and may be accompanied by chills, dizziness, and fever. Repeated sunburn over a long period may contribute to the development of skin cancer and excessive wrinkling. Sunburn can be avoided by the use of sunscreen lotions, which block out the sun's burning rays, or by gradual exposure to the sun, which results in suntan. However, repeated suntanning also may contribute to the development of skin cancer and wrinkling.

Tumors are abnormal growths of cells that may be cancerous or noncancerous. Cancerous tumors—also called *malignant* tumors—are more serious because they can invade surrounding tissue and may spread to distant sites and grow there. For a discussion of cancerous tumors, see the Skin cancer article.

Noncancerous tumors of the skin—also called *benign* tumors—do not spread to other parts of the body. These tumors include *lipomas, moles,* and *warts.* A lipoma is a large, soft lump of fat under the surface of the skin. A mole is a group of pigment cells that form a flat or raised spot on the skin. Most moles are black or brown. Warts, which are caused by a virus, may arise anywhere on the skin. Most warts are raised, rough, and dry, and do not cause pain. However, *plantar warts,* which grow on the bottom of the feet, sometimes press against nerve endings in the dermis and cause pain.

Other skin disorders include *acne, corns, hives, psoriasis,* and *vitiligo.* Acne most commonly afflicts teenagers. It consists of pimples, blackheads, and other blemishes, which appear mainly on the face, upper chest, and back. A corn is a painful thickening of the epidermis that occurs on the feet. Most corns result from pressure and friction caused by poorly fitting shoes. Hives are small, swollen, white or pink spots that itch. Many cases of hives are caused by allergic reactions to certain foods or medicines. Psoriasis is characterized by thick, raised, red patches of skin that are covered with silvery-white scales. Vitiligo consists of whitish patches of skin that have lost their pigment because the melanocytes have been destroyed.

Animal skin

All animals with backbones have skin that consists of an epidermis and dermis. However, the skin of each species has different characteristics and is especially suited to the animal's environment.

Only the skin of mammals is covered by hair. Most species have long, thick hair that helps keep them warm. In many species, the hair color blends with the surroundings and helps conceal the animal from enemies. Many animals have nails, claws, or hoofs, which help them obtain food and protect themselves. Claws are longer, sharper, and stronger than nails. Hoofs consist of the same kind of cells that make up nails and claws.

Birds have thin skin covered with feathers. A feather grows in a kind of follicle that resembles a hair follicle. Birds shed their feathers periodically. New feathers continually grow in the follicles and replace those that are shed. A bird has one large oil gland, which is located under its tail. The bird collects the oil from this gland in its beak and spreads it over its feathers. This process, called *preening,* makes the feathers waterproof.

Fish and amphibians have glands that secrete a slimy substance on their skin. The skin of many species of fish is covered by bony scales. Turtles have shells that consist of an inner layer of bone and an outer layer of skin tissues. Such reptiles as snakes and lizards have dry, scaly skin. Yelva Liptzin Lynfield

Related articles in *World Book* include:

Skin disorders

Acne	Eczema	Lupus	Scleroderma
Athlete's foot	Elephantiasis	Neurofibromatosis	Shingles
Bedsore	Epithelioma	Pimple	Skin cancer
Birthmark	Erysipelas	Prickly heat	Sunburn
Boil	Erythema	Psoriasis	Tumor
Burn	Hives	Ringworm	Vitiligo
Callus	Impetigo	Scabies	Wart
Corn	Leprosy		Wen
Dermatitis			

Other related articles

Depilatory	Nail
Dermatology	Perspiration
Epithelium	Pore
Gland	Races, Human
Hair	Scar
Mole	

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Skin cancer is the world's most common form of cancer. Like nearly all living tissue, the skin constantly forms new cells to replace worn ones. But some harmful factors—especially the sun's rays—can damage the *genes* (hereditary material) in skin cells. When certain genes are damaged, cells can multiply wildly instead of dividing in their normal orderly way. Cancer arises from this uncontrolled multiplication.

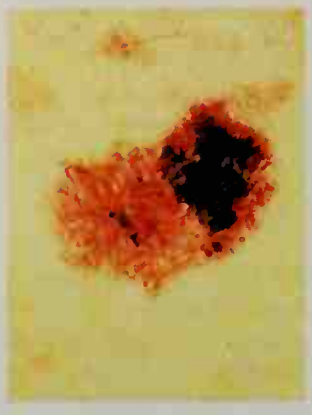
The best way to prevent skin cancer is to protect the skin from excess sun. Doctors believe that people could avoid many skin cancers with such measures as using sunscreen regularly and wearing protective clothing.

Doctors group skin cancer in two broad categories that reflect different levels of seriousness of the disease. The more serious category is a dangerous skin cancer called *melanoma (MEHL uh NOH muh).* The other category—*nonmelanoma skin cancer*—is much easier to treat.

Melanoma arises in *melanocytes (MEHL uh nuh syts),* the cells that make the pigment that gives skin its natural color. Some melanomas form in moles that change into cancer. Others begin to grow in skin with no previous markings. Melanoma is an extremely aggressive cancer that tends to spread to other parts of the body. But most melanomas that are detected early can be cured by removing the growth and a margin of healthy tissue.

Warning signs of melanoma

The ABCD guidelines help people remember how to watch moles for danger signs of melanoma, the deadliest skin cancer. In these guidelines, A stands for *a*symmetry, B stands for *b*order, C stands for *c*olor, and D stands for *d*iameter.



Asymmetry—the shape of one half is unlike the other.

Border around the mole is strikingly irregular.

Color varies from one area of the mole to another.

Diameter is larger than the diameter of a pencil eraser.

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Because early detection is so vital, doctors recommend that people learn the warning signs of melanoma and examine their skin regularly. Skin examination is especially important for people who have an increased risk of melanoma. Factors for increased risk include having light skin and green or blue eyes; having a large number of moles; and having already had a melanoma.

Doctors have developed a memory aid called ABCD to help people remember how to evaluate a pigmented area for danger signs of melanoma. In ABCD, *A* stands for *a*symmetry—that is, the shape of one side is unlike the other side; *B* stands for an irregular *b*order; *C* stands for variations in *c*olor; and *D* stands for *d*iameter greater than 6 millimeters (about the size of a pencil eraser). People should see a doctor immediately about an area that has any of these characteristics.

Nonmelanoma skin cancer occurs in two principal forms—*basal cell cancer* and *squamous cell cancer*. Both of these cancers can have a wide variety of appearances, including small red or pearly bumps; flat, scaly, red areas; or sores that do not heal. Experts recommend that people consult a medical professional about any change in their skin that lasts longer than about three weeks.

Basal cell cancer is the most common nonmelanoma skin cancer. It rarely spreads beyond the skin. Squamous cell cancer is slightly more likely to spread than basal cell. Because they usually do not spread, most nonmelanoma cancers can be cured by removing the affected skin. Cancer that has spread is more difficult to cure. People who have had one nonmelanoma skin cancer have an increased risk of forming additional cancers in their skin and in their other organs. Anyone who has had skin cancer should have regular medical checkups.

June K. Robinson

See also Cancer; Mole; Skin.

Skin disease. See Dermatology; Skin.

Skin diving is the act of going underwater while holding the breath or while breathing compressed air from tanks. Skin diving generally refers to *breath-hold diving*, the oldest and simplest form of diving underwater. Diving with the aid of air tanks is called *scuba diving*. Both kinds of skin diving are popular forms of recreation. Many people enjoy exploring the beautiful world beneath the surface of rivers, lakes, and oceans. Recreational divers explore, take underwater photographs and videos, capture tropical fish, and collect shells and other objects.

Professional and military scuba divers perform important tasks while underwater. For example, they repair ships, recover valuable objects, and help build and repair structures. Scientists and students use scuba equipment to help in the study of underwater biology and geology.

Many skin divers carry such equipment as bags made of netting or canvas, knives, and underwater lights and other tools. Small fish can be captured with nets and suction devices. Spears are used to take food. Divers use special cameras to take underwater photographs, movies, and videos.

A diver may communicate with the surface or with other divers underwater with special electronic devices and may employ other electronic equipment to search for ships or lost objects. Special electronic meters and computers are used for safety and to record or display important information. Recreational divers most often communicate with hand signals.

Robert Abrams, Bruce Coleman Inc.

Scuba diving is a popular way to explore oceans, lakes, and rivers. Scuba divers breathe from metal tanks of compressed air that are strapped to their backs.

Kinds of skin diving

Breath-hold diving requires no equipment, but most skin divers wear a face mask, swim fins, and a short breathing tube called a *snorkel.* The face mask permits clear vision underwater. The flexible swim fins help a person swim with greater ease. The diver breathes through the snorkel while floating or swimming face-down at the surface.

A breath-hold diver may wear a *wet suit,* a close-fitting coverall made of a material similar to foam rubber, to keep warm in cold water. Some water may enter, but the diver's body heat warms this water, and the suit holds in the warmth.

Breath-hold divers may also wear a weighted belt and a *buoyancy compensator.* The belt's weight helps the diver stay at the desired depth instead of floating upward. The buoyancy compensator, which floats when inflated, also helps the diver maintain a desired depth and acts as a support if the diver wants to rest on the surface.

Breath-hold divers cannot descend deeply because they must continually return to the surface to breathe. Most divers can go 30 to 40 feet (9 to 12 meters) deep and must surface after less than a minute. Some can dive as far as 100 feet (30 meters) and remain submerged from one to three minutes. Breath-hold divers can safely increase their time underwater by remaining relaxed and swimming slowly.

Some divers take two or three deep, rapid breaths before diving. This process, called *hyperventilation,* enables people to hold their breath longer. Excessive hyperventilation should be avoided because the diver may misjudge the need to breathe and pass out underwater.

Scuba diving involves the use of portable metal tanks that supply compressed air for the diver to breathe. A diver using one tank can remain at a depth of 40 feet for about an hour. Strenuous activity or diving deeper will cause the diver to use the air supply faster and greatly reduce the duration of the dive. The word *scuba* stands for *s*elf-*c*ontained *u*nderwater *b*reathing *a*pparatus.

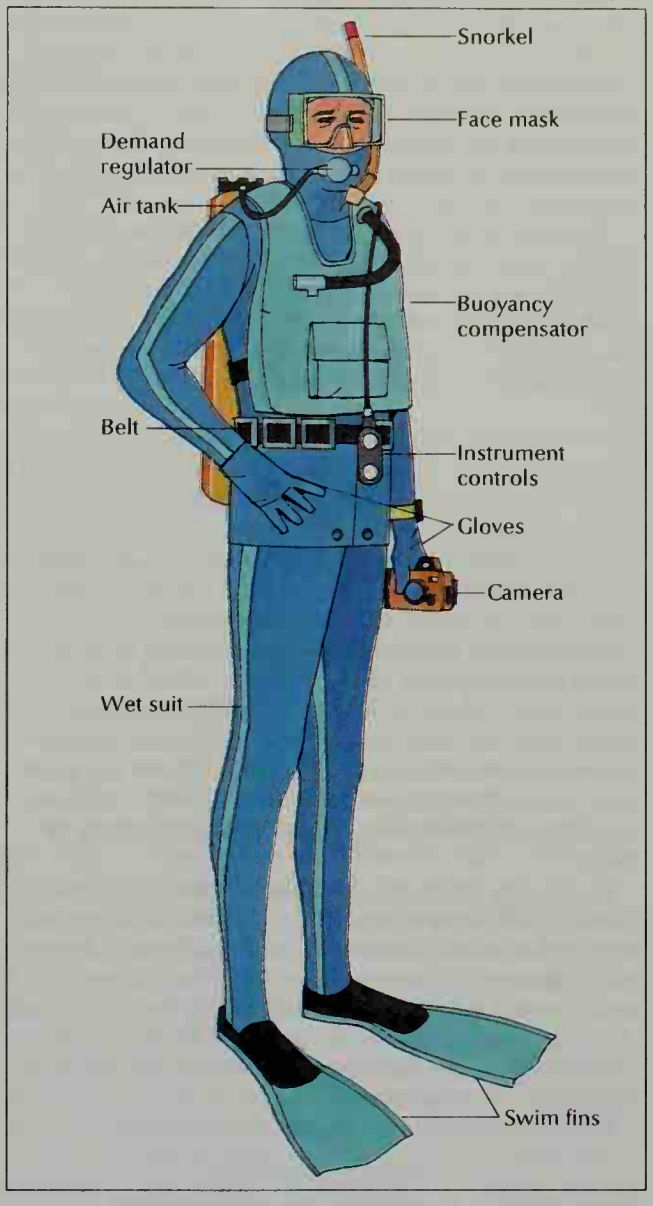
Scuba gear consists of one or more tanks and a demand regulator that includes the air hose and mouthpiece. The regulator controls the flow of air so that the pressure within the diver's lungs equals the pressure of the water. The pressure underwater is greater than on land and increases with depth. Serious injury can result if the pressure in a diver's lungs is not equal to the surrounding water pressure (see **Diving, Underwater** [Dangers of underwater diving]).

Scuba divers may also use a mask, wet suit, weighted belt, fins, snorkel, and buoyancy compensator. In warm tropical waters, divers may wear a lightweight suit of colorful fabric instead of a wet suit for protection and warmth. Scuba divers breathe through the snorkel while swimming at the surface and thus conserve the air in the tanks. The buoyancy compensator can be inflated underwater to help the diver maintain the desired depth, to change depths, and to rest on the surface.

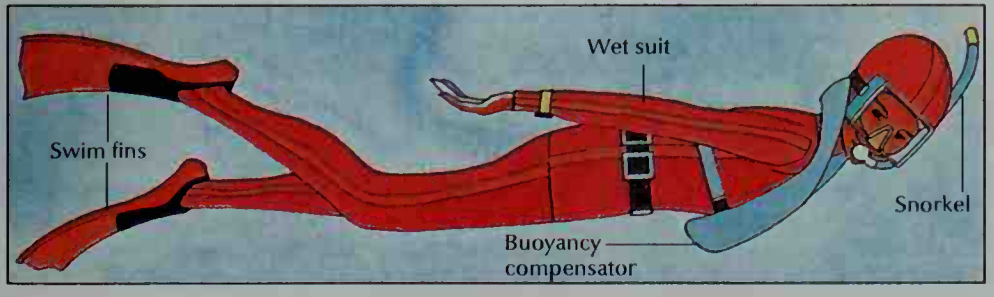
Scuba-diving equipment

Scuba divers carry tanks of compressed air. The demand regulator controls the flow of air. The buoyancy compensator can be inflated if the diver wants to return to the surface quickly.

WORLD BOOK illustration by David Cunningham



WORLD BOOK illustration by David Cunningham



Breath-hold divers usually use a face mask and swim fins in addition to a snorkel. The mask provides clear vision underwater, and the fins help divers swim with less effort.

Learning to dive

Beginning divers should seek instruction from a qualified teacher who has been certified by a recognized organization. These organizations include the National Association of Underwater Instructors (NAUI), the Professional Association of Diving Instructors (PADI), Scuba Schools International (SSI), or the Young Men's Christian Association (YMCA). Certified instructors can be contacted at diving equipment stores, colleges and universities, community swimming pools, seaside tropical resorts, and some YMCA's.

A trained scuba diver with relatively little experience should restrict diving to depths of 60 feet (18 meters) or less. Even experienced divers should avoid depths greater than 130 feet (40 meters). Advanced training and a wide range of supervised diving experience are important before venturing to greater depths.

History

For thousands of years, people have dived underwater in search of food and to gather pearls, shells, and sponges. Early divers used no equipment. Divers probably began using snorkels made of hollow reeds about A.D. 100. By 1300, Persian divers were using goggles made from the polished shells of tortoises.

Independent breathing devices for diving were first tested during the late 1800's and early 1900's. In the 1930's, divers began to use rubber goggles with glass lenses, and also face masks. Two Frenchmen, Jacques-Yves Cousteau and Émile Gagnan, developed the *aqualung,* one of the first breathing devices with a demand regulator. Cousteau tested the device successfully in 1943.

During the 1950's, diving began to grow as a recreational sport in the United States. The Underwater Society of America was formed in 1959. It promotes diving safety, sports, and conservation. A number of organizations provide information on skin diving instruction and skin diving clubs. One of the largest is the National Association of Underwater Instructors, based in Montclair, California. Arthur H. Ullrich, Jr.

See also **Diving, Underwater; Spearfishing.**

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Skin grafting is a surgical method of replacing skin to cover wounds. Skin grafts are especially useful in healing severe burns. Loss of skin due to serious accidents, disease, or surgery may also require skin grafting.

Most skin grafts involve taking healthy skin from one part of a patient's body to cover a wound on another part of the body. This type of skin graft is called an *isograft* or *autograft.* The grafted skin may be either *full thickness* or *partial thickness.* A full thickness graft includes all the *epidermis* (top layer of skin) and the *dermis* (layer of blood vessels, nerve endings, and connective tissue). A partial thickness graft uses all of the epidermis but only a little of the dermis.

The part of the body from which the skin graft has been taken is called the *donor site.* If a partial thickness skin graft has been removed, the donor site heals in several days, much like a "skinned" knee or ordinary scrape. When a full thickness graft is removed, the donor site must be closed surgically. The final result of a skin graft does not feel or appear exactly like normal, uninjured skin. After several years, however, the differences between grafted skin and normal skin are usually slight.

Some patients do not have enough undamaged skin to provide isografts for the entire wound. In such cases, surgeons may cover some of the wound with temporary skin grafts. These grafts help prevent infections and fluid loss, but the body eventually rejects the covering. Many temporary grafts use skin from another person. Such grafts are called *homografts* or *allografts.* Other temporary grafts, known as *heterografts* or *xenografts,* use specially prepared skin from pigs or other animals. Surgeons replace temporary grafts with isografts after the patient's body has produced new skin at earlier donor sites. Researchers have also developed "artificial skins" that can serve as temporary grafts.

In the mid-1980's, surgeons began using large sheets of "test tube" skin grown in a laboratory to serve as permanent grafts for victims of extensive burns. The skin is grown from tiny patches of healthy skin taken from the patient's body. A. Griswold Bevin

See also **Plastic surgery.**

Skink is any of a large group of small lizards that live in mild and tropical regions. There are about 1,100 species of skinks. They are most common in Australia, Africa, Asia, and islands of the western Pacific Ocean. Only a few species live in North America.

Cosmos Blank, National Audubon Society from Photo Researchers

The western skink lives in southern British Columbia and the western United States. There are about 1,100 species of skinks. They inhabit mild and tropical regions.

Most skinks are active during the day. They generally hunt for small insects. A few species eat other lizards or plants. Most species live on the ground, but some are found in trees, on rocks, or underground.

The largest skinks grow up to 2 feet (60 centimeters) long. However, most skinks measure less than 16 inches (41 centimeters). Skinks have scaly skin that may be brightly colored or striped. Small pieces of bone under their scales provide a protective suit of armor. Most skinks have short, weak legs and move slower than other lizards. Some skinks that live beneath the surface have no legs at all. They burrow through soil using wriggling, snakelike movements. Most females lay eggs. In a few species, the females guard the eggs until they hatch.

The females of many species bear live young.
Raymond B. Huey

Scientific classification. Skinks make up the family Scincidae.

Skinner, B. F. (1904-1990), was an American psychologist best known for his theories about learning and his belief in a planned society. Skinner was a leading supporter of *programmed instruction,* in which material to be learned is presented in a sequence of small units that gradually increase in difficulty. He also gained fame in the field of *behavioral psychology,* the study of the observable behavior of human beings. In a popular book, *Walden Two* (1948), Skinner described his idea of an ideal planned society. In *Beyond Freedom and Dignity* (1971), he called for restriction of individual freedoms that hinder development of the ideal planned society.

Burrhus Frederic Skinner was born in Susquehanna, Pennsylvania, on March 20, 1904. He graduated from Hamilton College in 1926 and earned a Ph.D. at Harvard in 1931. He taught at several universities, then joined the Harvard faculty in 1948. Skinner developed the theory of *operant conditioning,* in which experimenters can shape the behavior of people or animals with positive or negative responses. During World War II (1939-1945), he created his first "baby box," a controversial controlled environmental chamber for infants. His daughter Deborah spent part of her first two years in such a chamber. Skinner died on Aug. 18, 1990. Robert G. Weyant

See also **Developmental psychology; Learning** (Instrumental conditioning).

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Skipper. See **Butterfly** (Skippers; pictures).

Skłodowska, Marie. See Curie, Marie S.

Skopje, *SKAHP yeh* (pop. 503,449), is the capital of Macedonia, a country in southeastern Europe. Skopje lies in northern Macedonia, along the Vardar River (see **Macedonia** [map]). Most of the city was destroyed or damaged by an earthquake in 1963. The city was rebuilt with earthquake-resistant construction. Historic structures that remain include an ancient fortress, a Turkish bath, and a Muslim mosque.

Products made in Skopje include agricultural machinery, beer, bricks, cement, chemicals, glass, steel, and tobacco products. Other industries include food processing, leather processing, and woodworking.

The city, originally known as Scupi, became an important settlement in the kingdom of Illyria about 3,000 years ago. From the A.D. 300's to the 500's, it was an economic, political, and religious center of a Roman district. After occupation by Slavs in 695, the city received the name Skopje. Sabrina P. Ramet

See also Macedonia (picture).

Skryabin, Alexander. See Scriabin, Alexander.

Skua, *SKYOO uh,* is the name of a group of birds that live for much of the year over the ocean. Most skuas live on the coast of Antarctica or on nearby islands. Skuas are fierce birds with strong, hooked beaks. They have brown and white feathers. They often attack gulls and terns far out over the sea, taking the fish that those birds have caught. Skuas will also eat smaller birds and their eggs. Skuas build their nests of sticks and grasses on the ground or on bare rocks. They do not conceal their nests, but they fight to protect them. The female usually lays two eggs. Fritz L. Knopf

Scientific classification. Skuas make up the genus *Catharacta* in the family Laridae.

See also **Antarctica** (Animal life; picture); **Bird** (picture: Birds of the ocean and the Antarctic).

Skull is the bony frame of the head of human beings and other animals with backbones. It is a case made up of bones that enclose the brain and bones that form the face. The human skull has 22 bones. Eight bones enclose the brain and make up what is called the *cranium.* These eight bones are called the *cranial bones.* The cranial bones are the *occipital,* at the back of the skull; the *sphenoid,* at the base of the skull; two *parietal* bones, at the top and sides; two *temporal* bones, above the ears; the *frontal,* at the forehead; and the *ethmoid,* at the nose. The other 14 bones of the skull form the face and the jaw. They are called *facial bones.*

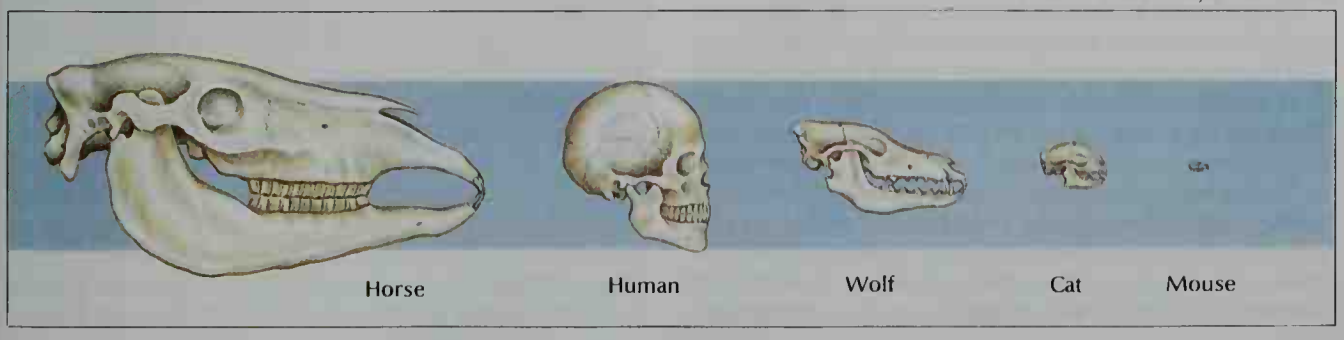
Except for the *mandible* (lower jawbone), all the skull bones of an adult form a rigid, united structure. But the skull bones of babies are still growing and are soft where the bones join. After a few years, the bones grow together in a hard, zigzag joint called a *suture.*

Animal skulls are shaped in ways that help the animal feed according to its way of life. For example, a wolf or cat has long jaws and strong, sharp teeth that are used to grasp and tear its prey. A horse's broad jaw and flat-edged teeth are shaped for cutting and grinding grasses and plants. A whale's streamlined skull is suited to the animal's life in the water. Charles W. Cummings

See also the Trans-Vision three-dimensional picture with **Human body**; also **Head; Mastoid; Prehistoric people** (pictures); **Sinus.**

Comparative sizes of skulls

WORLD BOOK illustrations by Sarah Woodward



Bruce Coleman Inc.

The striped skunk sprays an enemy only after giving a warning by growling and stamping its front feet.

Skunk is a small furry animal with distinctive black and white markings. It is known for the foul-smelling liquid it sprays when frightened or in danger. The odor remains for days on whatever has been sprayed.

The sprayed liquid, which is called *musk,* comes from a pair of glands near the base of the skunk's tail. The animal can spray accurately as far as 12 feet (4 meters). Before it sprays, a skunk gives warning by stamping its front feet and by hissing or growling. There are three chief types of skunks: (1) *striped,* (2) *hog-nosed,* and (3) *spotted.*

The striped skunk has two white stripes that form a large V down its back. White fur covers the top of its head, and a thin white stripe runs down the center of its face. Most striped skunks grow from 13 to 18 inches (33 to 46 centimeters) long, not including the tail, and weigh from 3 to 10 pounds (1.4 to 4.5 kilograms). The striped skunk is the most common species in the United States. It also lives in Canada and in northern Mexico.

The hog-nosed skunk resembles the striped skunk. But the hog-nosed skunk has a bare, protruding snout and lacks a face stripe. Some of these skunks have an entirely white back and tail. Most hog-nosed skunks grow from 14 to 19 inches (36 to 48 centimeters) long and weigh from 4 to 10 pounds (1.8 to 4.5 kilograms). Hog-nosed skunks are the only skunks found in South America. They also live in Central America and in the Southwestern United States.

The spotted skunk has large white blotches all over its body. A triangular patch of white marks the forehead. Spotted skunks grow from 7 to 14 inches (18 to 36 centimeters) long and weigh from 1 to 3 pounds (0.5 to 1.4 kilograms). They live in the United States and as far south as Central America.

Many skunks live in underground dens that they line with dry leaves. The spotted skunk, unlike the striped and hog-nosed species, can climb, and it sometimes lives in hollow trees. Skunks are active at night and sleep during the day. Most female skunks give birth to four or five young at a time.

Skunks eat caterpillars and such insects as beetles, crickets, and grasshoppers. They also eat mice, rats, and other small rodents. Sometimes they eat eggs, fruit, grain, and the rotting flesh of dead animals. Skunks have few natural enemies, though bobcats and great horned owls have been known to attack them.

John H. Kaufmann and Arleen B. Kaufmann

Scientific classification. Skunks belong to the weasel family, Mustelidae. The scientific name for the striped skunk is *Mephitis mephitis.* Hog-nosed skunks form genus *Conepatus.* The spotted skunk is *Spilogale putorius.*

See also **Animal** (picture: Animals of the temperate forests); **Polecat.**

Skunk cabbage is a soft-stemmed plant found in low swamps in eastern and central North America. It is known for its heavy, skunklike odor. Skunk cabbage is called a *perennial* because its roots send up new stems each year. The roots are heavy and coarse. The small flowers grow in a thick spike, which is surrounded by a brown leaflike organ called a *spathe.* The spathe gives off an unpleasant odor. The leaves of the skunk cabbage are broad and 1 to 3 feet (30 to 91 centimeters) long. The leaves grow in tufts. David A. Francko

Scientific classification. The skunk cabbage belongs to the arum family, Araceae. It is *Symplocarpus foetidus.*

Sky is the region of space visible from the earth. The sky consists of the atmosphere, which extends hundreds of miles or kilometers above the earth. The atmosphere is composed chiefly of nitrogen and oxygen. In addition, it contains tiny water droplets and ice crystals in the form of clouds and precipitation. Smoke, dust particles, and chemical pollutants may also fill the sky over cities.

The colors of the sky result from the scattering of sunlight by the gas molecules and dust particles in the atmosphere. Sunlight consists of light waves of varying wavelengths, each of which is seen as a different color (see **Light** [Electromagnetic waves]). The shortest light waves appear blue and the longest red. The blue light waves are readily scattered by tiny particles of matter in the atmosphere, but the red light waves travel undisturbed unless they are struck by larger particles.

When the sky is clear, the waves of blue light are scattered much more than those of any other color. As a result, the sky appears blue. When the sky is full of dense clouds or smoke, the light waves of all colors are scattered, causing the sky to turn gray. At sunrise or sunset, sunlight must travel farther through the atmosphere than when the sun is overhead. Light waves of most colors are scattered. Undisturbed red light waves give the sun and sky near the horizon a red or orange appearance. T. Theodore Fujita

Skydiving is a sport in which one or more people jump from an airplane and fall freely before opening a parachute. Skydiving is also known as *sport parachuting.* Skydivers typically jump at altitudes of up to 15,000 feet (4,600 meters) and fall at speeds of more than 100 miles (160 kilometers) per hour. They open their parachutes at 2,000 to 3,000 feet (600 to 900 meters) and then glide to earth at about 10 miles (16 kilometers) per hour.

In *accuracy skydiving,* the jumper aims for a target that measures about 2 inches (5 centimeters) in diameter. In *relative work skydiving,* free-falling skydivers join together to make geometrically shaped formations.

There are about 250 skydiving centers in the United States. These centers offer skydiving instruction to people who are at least 16 years old.

Critically reviewed by the United States Parachute Association

Skye terrier is one of the oldest terrier breeds. It originated during the 1600's on the island of Skye, off Scot-

© Mark Segal, Panoramic Images

Skyscrapers rise above downtown Chicago near the city's lakefront. The 110-story Sears Tower, the tallest building in the United States, stands at the left. The 80-story Aon Center stands at the right. The first skyscrapers were built in Chicago and New York City in the late 1800's.

land. It is a good house pet and a good rat hunter. The Skye is only 8 to 10 inches (20 to 25 centimeters) high, but its body is about 22 inches (56 centimeters) long. It has long hair that hangs down over its eyes. Its ears may be either erect or hanging. Its coat is about 5 inches (13 centimeters) long and may be dark or light blue, gray, or fawn. See also **Dog** (picture: Terriers); **Terrier.**

Critically reviewed by the American Kennel Club

Skyjacking. See Hijacking.

Skylark. See Lark.

Skyscraper is the name given to the world's tallest buildings. These giant structures first appeared during the late 1800's in Chicago and New York City. Skyscrapers provide space for business offices, apartments, stores, hotels, restaurants, post offices, sports clubs, and other facilities. Some skyscrapers have so much space and serve so many functions that they resemble small cities.

Stephen Wood, United States Parachute Association

Daring skydivers make a controlled free fall before opening the parachutes that allow them to float safely to the ground.

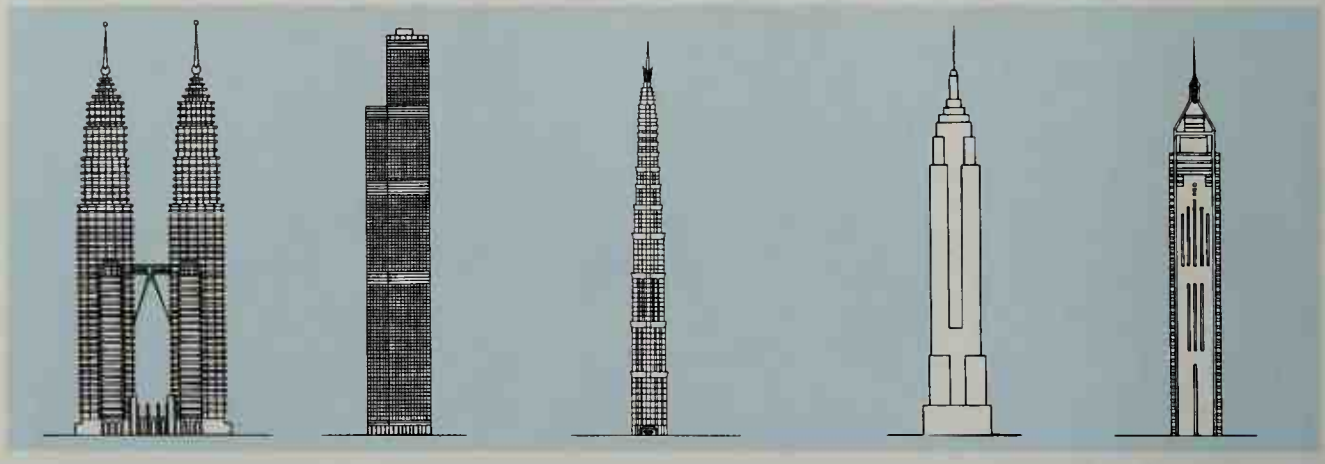
Building skyscrapers. Skyscrapers have two main parts, the *foundation* (the part below ground) and the *superstructure* (the part above ground). Both parts help support the *load* (weight or force) of the building. In skyscrapers over 40 stories tall, the *wind load*—that is, the force of the wind blowing against the sides of the building—becomes more important than the weight. The superstructure transmits the load to the foundation. The foundation consists of steel or concrete columns called *piles* that rest on a layer of solid rock or soil. The foundation transmits the load to this supporting layer.

In most buildings less than four stories high, the walls transmit the load to the foundation, but skyscrapers require a different type of construction. In skyscrapers, a steel or concrete frame supports the building much as a skeleton supports a body. The walls transmit no load but merely hang on the frame like curtains. The beams, girders, and columns that make up this skeleton carry the loads of the roof, walls, and floors.

Building a skyscraper requires careful planning. First, the construction crew digs a hole one or more stories deep for the foundation. During this process, factory-made pieces of the frame, such as steel beams and columns, are delivered to the site. After completing the foundation, the crew uses cranes to raise the pieces of the frame and then bolts them together.

As the frame goes up, other workers lay the floors and put on the outside walls. They finish the lower stories before completing the top of the skyscraper, but they must complete the entire building before installing elevators and other systems. A construction firm can put

Some of the world's tallest skyscrapers are pictured here. The heights given measure the distance from the sidewalk to the structural top of each building, excluding antennas or flagpoles. The spires atop the Petronas Towers are considered an integral part of the buildings.



WORLD BOOK illustration by Arthur L. Grebetz

Petronas Towers	**Sears Tower**	**Jin Mao Building**	**Empire State Building**	**Central Plaza**
Kuala Lumpur, Malaysia	Chicago	Shanghai	New York City	Hong Kong
1,483 feet	1,450 feet	1,380 feet	1,250 feet	1,227 feet
(452 meters)	(442 meters)	(421 meters)	(381 meters)	(374 meters)

The world's tallest skyscrapers*

Name of building	City	Stories	Height†		Year completed
			In feet	In meters	
Petronas Towers‡	Kuala Lumpur, Malaysia	88	1,483	452	1998
Sears Tower	Chicago	110	1,450	442	1974
Jin Mao Building	Shanghai, China	88	1,380	421	1998
Citic Plaza	Guangzhou, China	80	1,283	391	1996
Shun Hing Square	Shenzhen, China	81	1,260	384	1996
Empire State Building	New York City	102	1,250	381	1931
Central Plaza	Hong Kong, China	78	1,227	374	1992
Bank of China Tower	Hong Kong, China	70	1,209	369	1989
Emirates Tower One	Dubayy, United Arab Emirates	55	1,165	355	2000
The Center	Hong Kong, China	79	1,148	350	1998

*The World Trade Center, which measured 1,368 feet (417 meters), was destroyed by terrorists on Sept. 11, 2001.
†Measured from sidewalk level of main entrance to structural top of building; excludes antennas and flagpoles.
‡Two towers of equal height.
Source: Council on Tall Buildings and Urban Habitat.

up a skyscraper frame in a few weeks, but it may take several years to finish the building.

Service areas. A skyscraper's interior contains rentable space and service areas. Service areas include corridors, stairs, lobbies, elevators, and machine rooms. These areas provide such internal systems as plumbing, air conditioning, electrical systems, and elevators.

Plumbing systems consist of a *water supply system* and a *drainage system.* The water supply system brings clean water to plumbing fixtures. In a skyscraper, pumps increase the pressure within the pipes so that water reaches the upper floors of the building. The drainage system carries away water and waste materials.

Air conditioning systems control the temperature within skyscrapers. Most air conditioners used in large buildings heat air by blowing it over coils filled with hot water or steam. A boiler heated by a gas or oil burner produces the hot water or steam. In some air conditioners, electric heaters warm the air. To cool the air, most air conditioners blow the air over coils filled with cold water or a chemical refrigerant.

The air conditioning system then circulates the warmed or cooled air throughout the skyscraper. Fans blow conditioned air into a room through ducts. Other fans return used air and blow some of it out of the building. The system returns the remaining used air to the air conditioner and mixes it with air from outside.

Electrical systems provide power and communication systems. In many skyscrapers, power from the local utility company enters at the base of the building. Wires carry the electric current to each floor and supply power for lighting, office equipment, and other purposes. Electrical systems also provide skyscrapers with communication systems, including telephones and computers. In some skyscrapers, builders mount a second floor on top of the structural floor to create a space for the wiring needed for telephone, computer, and power systems. In others, ducts within the structural floor enclose wiring.

Elevators in skyscrapers travel at speeds as high as 2,000 feet (600 meters) per minute. A group of elevators typically serves a zone of 15 to 20 floors (see **Elevator**).

History. The many parts and systems of a modern skyscraper did not all appear at once. The skyscraper developed in stages during the second half of the 1800's. At that time, builders began to use safety elevators, metal frames, and other new technologies that made the modern skyscraper possible. Before elevators, for example, the height of buildings was limited by the number

of stairs people were willing or able to climb.

Skyscrapers first emerged in Chicago and New York City. In these cities, business people wanted concentrated centers that would provide quick access to offices, warehouses, and banks. Rising land costs also increased the desire to build upwards. The Home Insurance Building (1884-1885) in Chicago, designed by William Le Baron Jenney, was a well-known "ancestor" of the skyscraper. This 10-story building, which was demolished in 1931, had a metal frame that supported much of its load. Matthew A. Dettman

Related articles in *World Book.* See the pictures in the articles for such cities as Chicago; New York City. See also:

Architecture
Building construction
Burnham, Daniel H.
Empire State Building
Jenney, William Le Baron
Malaysia (picture: Petronas Towers)
Mies van der Rohe, Ludwig
Sears Tower
Sullivan, Louis Henri
World Trade Center

Slag is the nonmetallic material removed in the process of making pig iron, and in smelting copper, lead, and other metals. The slag from steel blast furnaces contains sulfur and silicates of calcium, magnesium, and aluminum. The slag from copper and lead-smelting furnaces contains iron silicate, and oxides of other metals in small amounts. Slag from steel furnaces contains lime, iron oxide, and silica. Often it is smelted again to recover the iron. Slag is sometimes used in the manufacture of cement and the building of roads. Gordon H. Geiger

Slalom. See Skiing (Alpine competitions).

Slander is a spoken untruth that injures a person's reputation. Writing or printing a similar statement is called *libel.* There is confusion whether to view spoken untruths on radio and television as libel or slander. But the trend is to treat such spoken untruths as libel.

In the United States, a person who believes he or she has been slandered can file a lawsuit in civil court. To win such a suit, the *plaintiff* (person filing the charges) must prove either that a false statement caused a loss of money or that such a statement had any of the four following effects: (1) suggested the plaintiff committed a crime; (2) tended to injure the plaintiff's business or profession; (3) suggested the plaintiff had a medical disorder, such as leprosy or a sexually transmitted disease; or (4) accused a female plaintiff of a lack of chastity or accused either a male or a female plaintiff of serious sexual misconduct. Jeremy Cohen

See also Libel.

Slang is the use of informal, nonstandard words and phrases in new or unusual ways. Slang exists in all languages and has probably existed since the origin of spoken communication. The use of slang helps to create and reinforce a group identity. Many slang terms are expressive, humorous, and vivid. Some are crude and offensive. A slang expression may be a new word, such as *glitzy* (gaudy) or *hype* (advertising that relies on gimmicks or tricks). Or it may be an old word with a new meaning, such as *fly* (stylish) or *cool* (sophisticated).

People use slang more often in speaking than in writing, and more often with friends than with strangers. Slang thus resembles *colloquialisms,* which are expressions used in everyday conversation but not considered appropriate for formal speech or writing. Unlike colloquialisms, which may be understood by most people, many slang expressions are only used by a certain segment of society or by people in a specific occupation. The special slang and technical vocabulary of a profession or trade is known as *jargon.*

Some slang phrases have meanings that cannot be determined from the ordinary meanings of the words. Such phrases, including *kick the bucket* (to die) and *up the creek* (in trouble), are called *idioms.*

Slang expressions change and spread so quickly that many people have difficulty determining what is slang and what is not. Dictionaries and language experts often disagree about whether a particular expression is slang, a colloquialism, or even standard language.

Uses of slang

Slang has a wide variety of uses. Many people use it because they want to seem fashionable and modern. Others use slang because it is frank and informal, expresses friendliness, and puts people at ease.

Many slang terms are used to insult. A person considered to be unpleasant can be described as a *dork, geek, creep,* or *wimp.* Some insulting slang words refer to certain ethnic, racial, and religious groups. Slang is also used to criticize or poke fun at established institutions.

Some slang expressions are used chiefly by members of certain groups. Group slang is often used to demonstrate membership in—and loyalty to—the group. This type of slang may also be used to maintain secrecy because people who do not belong to the group are unfamiliar with it. In a hospital, a physician may be called to the emergency room *stat* (quickly) because a patient has *flatlined* (lost all heart functions).

People also often use slang expressions to express themselves vividly. Young people often use slang to describe excellence, types of music, fashion trends, or sports. For example, slang synonyms used to describe excellence include *awesome, bad, cool,* and *tough.*

Slang can also refer to painful or frightening situations. A person may describe someone losing control as *going postal,* a reference to a series of incidents in the late 1900's in which postal workers shot co-workers. Such language attempts to relieve anxiety by substituting a light-hearted or indirect expression for an unpleasant or direct one.

Forms of slang

Slang expressions arise in the same ways that other words come into being. There are seven chief forms of slang, each created by a different process. These forms are (1) old words used in new ways, (2) shortened or lengthened words, (3) figures of speech, (4) rhyming slang, (5) acronyms, (6) coinages, and (7) blends.

Old words used in new ways create many slang expressions. The *flap* (commotion) over political campaign finance reform is slang, but the *flap* (hinged section) of an airplane wing is not. To *rip off* (steal) a camera is slang, but to *rip off* the top of a box is standard English.

Shortened or lengthened words also produce new slang. The process of creating a new word by dropping one or more syllables from a longer word is called clipping. Clipping produces many slang terms, such as *demo* (demonstration), *psycho* (psychopath), and *rep* (reputation). Another type of shortened word is a *back-formation.* Most slang back-formations are verbs formed by dropping the ending from a noun. Examples of such

verbs include *burgle* (to steal), from *burglar;* and *letch* (to lust), from *lecher.* In the reverse process, a new word may be created by adding an ending to an existing one. Slang words created by this process include *payola* (graft), from *pay;* and *slugfest* (fight), from *slug* (to hit).

Figures of speech are expressions in which words are used in unusual ways. One of the most common slang figures of speech is the *metaphor,* an implied comparison between two different things. For example, the slang metaphor *bean pole* describes someone thin.

Another type of slang figure of speech is *metonymy,* which substitutes a quality of something for the thing itself. Examples of metonymy include *greenbacks* (United States dollars) and *suit* (person in authority).

Rhyming slang is slang that replaces a word with a word or phrase that rhymes with it. Many cockneys in England and many Australians use such slang. For example, a cockney might say *Rosie Lee* for *tea.*

Acronyms are words formed from the first letters or syllables of the words in a phrase. This form of slang includes *D. J.* or *deejay,* from *disc jockey;* and *kidvid* (children's television programs), from *kid video.*

Coinages are newly invented words or phrases. Slang coinages include *humongous* (huge), *moola* (money), and *zit* (pimple).

Blends are new words created by joining the first part of one word to the second part of another. Examples of slang blends are *gyrene* (United States marine), from *G. I. marine;* and *sexploitation* (commercial exploitation of people's interest in sex).

Sources of slang

Much slang comes from the special vocabulary of certain groups within a general population. These groups may be based on such factors as age, ethnic background, and occupation. Jargon and other group language often spreads beyond the group that originated it and becomes general slang. The terms *joint* (cheap bar or restaurant) and *scram* (to get away quickly) originated as criminal *argot,* a special form of slang used by a specific group. Theater jargon produced such expressions as *ham it up* (to overact) and *turkey* (failure). Jazz musicians invented *gig* (job), *bag* (special interest), and *chops* (talent). African Americans contributed many expressions, including *dig* (to understand) and *hood* (neighborhood). The Yiddish language was the source of such terms as *dreck* (junk) and *klutz* (clumsy person).

All slang terms were invented by someone, but only a few can be traced to a specific person. Jack Conway, a writer for the entertainment newspaper *Variety,* invented *pushover* (something easy) in the early 1900's. T. A. Dorgan, an American cartoonist and sportswriter of the same era, probably originated *dumbbell* (stupid person).

The increasing popularity of the Internet has brought a great deal of slang created and used by computer users. Slang terms include *cyber-* (dealing with computers and the Internet), *snail mail* (written messages delivered by the postal service), *hacker* (an expert computer programmer perhaps involved in illegal activities), and *spamming* (sending unsolicited messages to users).

The spread of slang

Most slang spreads by word of mouth, making the paths of many expressions difficult to trace. Language scholars have found that much slang originates in social groups with lower incomes, less education, and less power than the rest of society. For example, many expressions spread from young people or from minority groups to the larger society. But there are exceptions. Some slang is created by highly educated professionals, such as aerospace scientists and computer experts.

Radio and television also spread slang. A TV entertainer can introduce a new slang expression to millions of people at once, giving it almost instant popularity.

Many slang expressions die out soon after they become widely used. For example, *crazy* (wonderful) was briefly popular in the 1950's. Yet other slang terms last so long and become so widely used that they are considered colloquialisms. Examples include *belly laugh* (hearty laughter) and *half-baked* (not fully worked out).

A few slang expressions become part of the standard language. *Hairdo* was introduced in the 1920's as a slang term to describe a hairstyle. It became a standard word in less than 20 years. The words *hoax* and *strenuous,* which also began as slang, took longer to be accepted. Some slang words have been used for hundreds of years without reaching the status of colloquialisms or standard words. For example, *grub* (food) dates back to the 1600's, and *lousy* (bad) dates back to the 1700's. However, both of these words are still considered slang.

Attitudes toward slang

Some people disapprove of slang. They consider it inferior language and accuse those who use it of careless, lazy thinking. Some believe the use of slang limits a person's vocabulary and even weakens the standard language itself. Others assume that slang is stupid and vulgar because it often occurs in informal conversation, accompanied by grammatical errors and profanity.

Certainly, slang can easily be overused and misused. A slang term becomes tiresome if it is repeated too often. Likewise, slang is inappropriate for certain uses, including formal speeches, business letters, and schoolwork. A slang expression can also cause a loss of accuracy in communication because it may mean different things to different people.

However, the reasonable use of slang promotes lively speaking and writing. Slang is an important part of any language and helps keep a language fresh and alive. Many colorful and useful words have come from slang, such as *bootleg, jazz,* and *skyscraper.* John D. Battenburg

See also **Dialect.**

Additional resources

Green, Jonathon. *The Cassell Dictionary of Slang.* Continuum, 1998.

Lighter, Jonathan E., ed. *Random House Historical Dictionary of American Slang.* Random Hse., 1994-. Multivolume work.

Slapstick comedy. See Humor; Sennett, Mack.

Slash-and-burn agriculture. See Agriculture (Shifting cultivation); Indian, American (Farming).

Slate is a fine-grained rock that can easily be split into thin slabs. It consists mainly of grains of mica, chlorite, and quartz and may also have calcite, pyrite, hematite, and other minerals. Most slate is gray to black in color, but the rock may be red or green, depending on its mineral content.

Slate is a *metamorphic rock* (see Metamorphic rock).

Most slate is formed below the earth's surface by changes in the makeup of shale, a *sedimentary rock* (see **Sedimentary rock; Shale**). Shale primarily consists of clay minerals and of fine particles of quartz. When shale is buried in the earth's crust, heat from deep in the earth or nearby *magma* (molten rock) changes the clay minerals in shale to mica and chlorite. Downward pressure caused by burial and deformation due to crustal movement squeezes the mica and other *platy* (flaky) minerals and forms them into parallel layers.

Much slate occurs in Scotland, Wales, France, southern Germany, and the Northeastern United States. Builders use slate for roofing and flagstones because it is weatherproof and long-lasting. Slate is also used to trim the fronts and lobbies of buildings, and for pool tables.

Maria Luisa Crawford

Slater, *SLAY tuhr,* **Samuel** (1768-1835), a British textile worker, founded the textile industry in the United States. Slater was born in Derbyshire. He came to the United States in 1789, after working for six years as an apprentice and manager in an English textile mill. At the mill, he learned the workings of the spinning machine developed by the British inventor Richard Arkwright. Slater left England in disguise because the British government prohibited any person who had knowledge of the design and operation of spinning machines from leaving the country. With this policy, Britain sought to maintain its world leadership in the production of textiles.

In 1790, Slater agreed to build the Arkwright machine from memory for Almy & Brown, a Rhode Island textile firm that wanted to use mechanical spinning techniques. Slater soon formed a partnership with Almy & Brown. The firm established the first successful spinning mill in the United States at Pawtucket, R.I., in 1790. Slater supervised the mill and hired children aged 7 to 14 to operate the equipment. In 1798, Slater established his own firm, Samuel Slater and Company, at Rehoboth, Mass. By the time of his death, Slater operated a number of mills in Connecticut, Massachusetts, New Hampshire, and Rhode Island.

R. Douglas Hurt

See also **Rhode Island** (Places to visit).

Slave Lake, Great. See Great Slave Lake.

Slavery is a practice in which people own other people. A slave is the property of his or her owner and works without pay. The owner, who is called a *master* or *mistress,* provides the slave with food, shelter, and clothing.

Slavery began in prehistoric times and has been practiced ever since. The slavery of ancient times reached its peak in Greece and the Roman Empire. During the Middle Ages, slavery declined. Then, during the 1500's and 1600's, the colonization of the New World by Europeans resulted in a great expansion of slavery. Changing moral attitudes about slavery helped cause its decline during the 1800's. The United States abolished slavery in 1865. Today, slavery is illegal in almost every country in the world. But slavery still exists in parts of Africa, Asia, and South America.

Development of slavery

The start of slavery probably followed the development of farming about 10,000 years ago. Farming gave people an opportunity to put their prisoners of war to work for them. People captured in war continued to be the chief source of slaves in the earliest civilizations. Other slaves were criminals or people who could not pay their debts.

Ancient times. The first known slaves formed the lowest class in the civilization developed by the Sumerians in Mesopotamia (now mostly Iraq) about 3500 B.C. Slavery also existed in Assyria, Babylonia, Egypt, Persia, and other ancient societies of the Middle East. In addition, it was practiced in ancient China and India and among the early blacks of Africa and the Indians of America. See **African Americans** (Beginning of the slave trade).

Slavery expanded as commerce and industry increased. This growth of trade created a demand for a disciplined labor force that could produce goods for export. As a result of this demand, ancient slavery reached its fullest development during the great empires of Greece and Rome.

Slaves did most of the work in these societies. Many labored in handicraft industries, in mines, or on plantations. Others worked as household servants, and some even became doctors or poets. During the 400's B.C., slaves may have made up a third of the population of Athens. In Rome, slavery became so widespread that even common people owned slaves. Most people of the ancient world regarded slavery as a natural condition of life that could befall anyone at any time. Few writers or other influential individuals viewed slavery as evil or unjust.

The treatment of slaves varied greatly, but almost no slaves could legally marry, have a family, testify in court, or own property. In ancient Greece and the Roman Empire, slaves who worked in large gangs in mines or on plantations served long hours and suffered harsh punishment. However, many of those who worked as household servants were treated as well as any member of the owner's family.

A slave's chief hope was *manumission* (formal release from slavery by the owner). Most ancient slaveholding societies allowed manumission, and many owners guaranteed it in their will as a reward for loyal service.

The Middle Ages. After the Roman Empire broke up in the A.D. 400's, international trade fell sharply. The loss of markets for goods that slaves might have produced led to a decline in the need for slaves. In Europe, slavery slowly changed into serfdom (see **Serf**).

But slavery continued in the areas around the Mediterranean Sea. Most of it resulted from fighting between two religious groups, Christians and Muslims. During the A.D. 600's and early 700's, Arab Muslims conquered the Middle East, North Africa, and almost all of Spain. Christians and Muslims fought each other in these areas for hundreds of years, and both groups enslaved their prisoners. Some of the fighting occurred during the Crusades—the Christian attempts to recapture Jerusalem and other areas of the Holy Land from the Muslims. The Crusades began during the 1000's.

In the Holy Land, the crusaders tasted sugar for the first time. Many of them then created a demand for sugar after returning to Europe. As a result, Italian merchants established sugar plantations on several Mediterranean islands. The production of sugar required large numbers of laborers, and so the Europeans imported slaves from Russia and other parts of Europe. By 1300, a

few African blacks had begun to replace Russian slaves on Italian plantations. These blacks were bought or captured from North African Arabs, who had enslaved them for years.

During the 1400's, Portuguese sailors started to explore the coast of West Africa and to ship African blacks to Europe as slaves. The Portuguese also enslaved blacks on sugar plantations that they established on islands off the coast of West Africa.

Throughout the Middle Ages, various peoples in Africa and Asia continued to enslave prisoners of war. During this period, slavery was widely practiced among three groups of Indians. These Indians lived on islands of the Caribbean Sea and also inhabited what are now the Northwest Coast and Eastern Woodlands of the United States. Most slaves in the Indian societies worked as farmers or domestic servants. They generally suffered less hardship than the slaves who toiled on European sugar plantations.

Modern times. The establishment of European colonies in the New World during the 1500's brought an expansion of slavery. The Spaniards developed sugar plantations in Cuba and on other Caribbean islands that became known as the West Indies. The Spaniards also needed large numbers of laborers to mine gold and other metals. Portuguese colonists started huge sugar plantations in Brazil. These Europeans enslaved thousands of Indians. But most of the Indians died from European diseases and harsh treatment. The Spaniards and the Portuguese then began to import blacks from West Africa as slaves. Other African blacks helped capture most of the enslaved Africans.

During the 1600's, France, England, and the Netherlands established colonies in the West Indies and greatly increased the African slave trade. Soon, the Europeans enslaved only blacks. Sugar became the main export of the European colonies, though the settlers also developed profitable coffee, cotton, and tobacco plantations.

The rising European demand for sugar helped create fierce competition for slaves and for new sugar colonies. From the 1500's to the mid-1800's, the Europeans shipped about 10 million black slaves from Africa to the Western Hemisphere. Nearly 2 million of these slaves died on the way. About 65 percent of the slaves were brought to Brazil, Cuba, Jamaica, Saint Domingue (now Haiti), and other sugar colonies. Brazil alone received about 38 percent. About 5 percent were brought to what is now the United States. See **Africa** (The beginnings of European control); **Colonial life in America** (The lower class).

Laws in the European colonies of Latin America showed considerable concern for the welfare of slaves. These laws allowed slaves to marry, to seek relief from a cruel owner, and even to buy their freedom. Such laws were rarely enforced, however. Partly for this reason, slavery was as cruel in Latin America as it was, later, in the United States. But slaves in the United States generally ate better, lived longer, received better medical care, and had a more secure family life than those in most other countries.

The continual shipment of large numbers of Africans to Latin America gave slaves there certain advantages over blacks brought to the United States. For example, African customs could be retained more easily in Latin America.

Slaves in Brazil and the West Indies had less need to adjust to white culture than did blacks in the United States. Blacks greatly outnumbered whites in parts of Brazil and in most West Indies colonies, but the Southern United States had twice as many whites as blacks. The greater number of slaves than whites in those Latin American areas also made slave revolts more common there than in the United States. The biggest slave revolt in history broke out in Saint Domingue in 1791. Nearly 500,000 slaves rebelled against their French owners and took over the country. See **Haiti** (History).

Detail of a relief sculpture from Trajan's Column (A.D. 113) in Rome (Art Resource)

People captured in warfare became the chief source of slaves in ancient Rome, shown here, and other early slaveholding societies. Today, slavery still exists in parts of Africa, Asia, and South America.

Slavery in the United States

The enslavement of blacks in the American Colonies began during the 1600's. Slavery flourished in the South, where large plantations grew cotton, tobacco, and other crops. The plantations required many laborers. But slavery was less profitable in the North, where economic activity centered on small farms and industries.

By 1860, the slave states had about 4 million slaves. The slaves made up nearly a third of the South's population. For more information on the history of slavery in the United States, see **African Americans** (The years of slavery); **United States, History of the** (Expansion; The irrepressible conflict).

Views of slavery. During the 1700's, noted philosophers and religious leaders in Europe and North America began to condemn slavery. They declared that slavery violated human rights and God-given law.

Many Americans turned against slavery during the Revolutionary War in America (1775-1783). These Americans came to believe that slavery had no place in a nation that had been formed to protect natural human

rights. Few people in the North owned slaves, and opposition to slavery developed more rapidly there than in the South. Some Southerners, including such leaders as George Washington and Thomas Jefferson, spoke out against slavery. Jefferson owned slaves, but he believed slavery was morally wrong and would someday have to end. He took no strong stand in his own state, Virginia, because he felt the people were not ready for such a step. The high profits that resulted from slavery had far greater influence than did any moral arguments.

Support of slavery remained strong throughout the South. But only about a fourth of the region's whites owned slaves or belonged to a family that owned them. About 45,000 planters owned over half the slaves, and these planters controlled the economy and government of the Southern States. Even the many Southerners who did not own slaves accepted the planters' view that the South's economy would collapse without slavery.

During the early 1800's, abolitionists started a crusade to end slavery. Southerners then began to defend slavery in what became known as the *proslavery movement.* Some Southerners in the movement argued that slavery reflected "the law of nature" that permitted the strong to rule the weak. Others insisted that the Bible supported slavery. Still others claimed that Southern slavery provided blacks lifelong security and better living conditions than they would have had in Africa. By 1860, most Southerners identified their honor and destiny with the continuation of slavery.

Functions of slaves. During the 1600's and 1700's, most slaves in what became the Southern States worked on plantations that grew chiefly indigo, rice, or tobacco. The cotton gin invented by Eli Whitney in 1793 resulted in fast, large-scale production of cotton. This fiber was the raw material most needed by U.S. and British industry. The high demand for cotton led to the establishment of cotton plantations throughout the South.

During the 1800's, most of the plantation slaves were *field hands* who planted and picked cotton. *House slaves* worked as servants in the owner's home. Other plantation slaves became skilled craftworkers such as blacksmiths, bricklayers, cabinetmakers, or carpenters.

Slaves also had a variety of jobs in Southern cities and towns. Many worked in factories. Others became construction workers on canals and railroads or worked as dockworkers, lumberjacks, office workers, or riverboat pilots. Still others toiled in mines.

Conditions of slavery. Owners housed their slaves and provided them with food and clothing. The amount and quality of these provisions varied widely.

Field hands worked longer than any other kind of slave, generally from sunrise to sunset. Some were housed as well as free workers. But many other field hands lived under the worst conditions.

Josiah Henson, who later wrote of his experiences as a field hand, recalled that "our dress was of tow-cloth . . . and a pair of coarse shoes once a year. We lodged in log huts . . . . Wooden floors were an unknown luxury. In a single room were huddled, like cattle, ten or a dozen persons, men, women, and children . . . . There were neither bedsteads nor furniture. . . . Our beds were collections of straw and old rags . . . . The wind whistled and the rain and snow blew in through the cracks, and the damp earth soaked in the moisture till the floor was miry as a pig-sty."

Most house slaves lived in their owner's home. They worked fewer hours and had more privileges than did field hands, but were more subject to the wishes of the owner's family.

No Southern state gave slaves the legal right to marry, own property, testify in court, or earn their freedom. Yet some slaves did all these things because slavery, like other human practices, had certain weaknesses. For example, owners had no guarantee of receiving willing obedience or even loyal service from their slaves. To encourage faithful service, some slaveholders treated their slaves kindly and promised them such privileges as gifts and money. Other owners relied on punishment, such as lashings, short rations, and threats to sell members of the slave's family. Whatever the system of discipline, slavery resulted in a contest of wills between owners and slaves. In this unequal contest, the owners held all the power of reward and punishment. But slaves used flattery, sabotage, and many other tactics to outwit them.

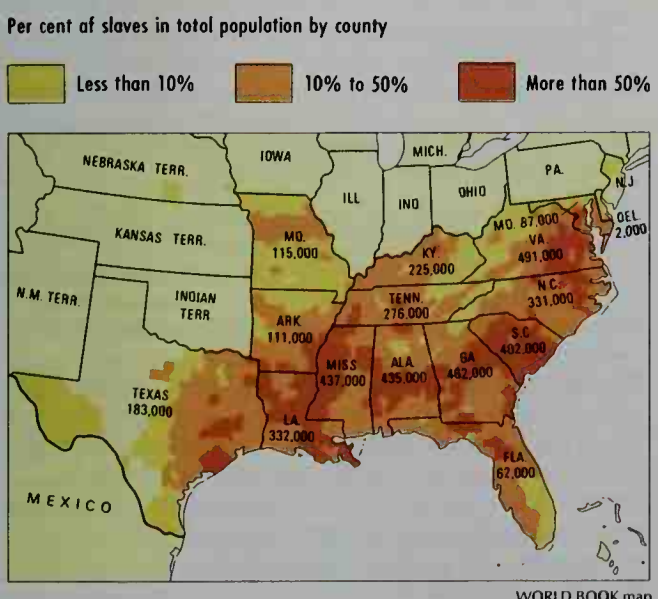
The religion of the slaves played a key role in helping them survive the brutality of slavery. This religion, a mixture of African and Christian beliefs, made the slaves feel part of a community. It also gave them hope of a better life in heaven. State laws prohibited the education of slaves. But the slaves developed their own language, music, and other means of communication.

Many slaves tried to run away to freedom. Thousands succeeded, including those who followed the runaway slave Harriet Tubman along an escape system called the *underground railroad.* Some joined organized rebellions, but whites easily crushed most revolts. In the United States, noted leaders of revolts included Gabriel (also called Gabriel Prosser), Nat Turner, and Denmark Vesey.

Effects of slavery included a major role in the economic development of the United States. Slaves helped clear the wilderness and build important canals, railroads, and roads. The cotton picked by slaves became

Slavery in the United States in 1860

Most United States slaves served on cotton plantations in the South before the Civil War. The map shows the approximate number of slaves in each state.



WORLD BOOK map

the nation's most valuable export. The income from cotton paid for a major share of U.S. imports.

The westward expansion of slavery during the early and mid-1800's had important political effects. Northerners feared that the South would gain control of Congress if Western territories entered the Union as slave states. Attempts by the North to exclude slavery from these territories angered the South and helped bring on the American Civil War (1861-1865).

Slavery had a variety of effects on slaves and owners. It broke the spirit of many blacks but made many others vow to resist it. Slavery caused fear and hate between most owners and slaves. But it created feelings of love and respect between some. After the Civil War, discrimination and a lack of education prevented most former slaves from obtaining a good job. Discrimination also kept them from receiving the civil rights they legally had been granted. Historians disagree over how much slavery contributed to discrimination and to other racial conflict that occurred in later years.

The decline of slavery

During the late 1700's, black slavery began to decline in various parts of the Western Hemisphere. The Revolutionary War in America helped cause gradual *emancipation* (freeing of slaves) in the North. In 1807, the British Parliament passed a bill outlawing slave trade. Also in 1807, the U.S. Congress prohibited the importation of slaves into the United States. The law took effect in 1808.

During the early 1800's, most of Spain's Latin American colonies won wars of independence. These countries immediately abolished slavery or adopted laws for gradual emancipation. In 1833, an act of Parliament called for the abolition of slavery throughout the British empire. In 1848, France freed the slaves in its remaining colonies in the Western Hemisphere. But slavery continued to expand in Brazil, Cuba, and the Southern United States. During the Civil War, Northern armies freed most of the slaves in the nation. Adoption of the 13th Amendment completed abolition in 1865. Spain ended slavery in Puerto Rico in 1873 and in Cuba in 1886, and Brazil abolished slavery in 1888.

Today, few nations legally allow slavery. But slavery does continue in areas of Africa, Asia, and South America. No one knows exactly how many people still live in slavery. Most of these slaves are blacks and Indians who were captured in local conflicts or were sold to satisfy debts. Slavery remains a strongly accepted custom among the people who practice it. Therefore, some governments may not want to stop slavery, and other governments may be unable to end it even if they wished to do so. David Brion Davis

Related articles in *World Book* include:

In ancient times

Aesop's fables
Egypt, Ancient (The people)
Greece, Ancient (The people)
Ireland (Saint Patrick)
Labor movement
Rome, Ancient (The people)
Spartacus

In America

See **Abolition movement** and its *Related articles* list. See also:

African Americans (The years of slavery; The end of slavery)
Allen, Richard
Amistad Rebellion
Buchanan, James (The struggle over slavery)
Cary, Mary Ann Shadd
Civil War
Compromise of 1850
Confederate States of America
Constitution of the United States (The compromises; Amendments 13, 14)
Crittenden Compromise
Dred Scott Decision
Emancipation Proclamation
Free Soil Party
Freedom Day, National
Fugitive slave laws
Gabriel
Kansas-Nebraska Act
Liberty Party
Lincoln, Abraham
Mason and Dixon's Line
Missouri Compromise
Plantation
Popular sovereignty
Proslavery movement
Reconstruction
Russwurm, John Brown
Tubman, Harriet
Turner, Nat
Uncle Tom's Cabin
Underground Railroad
Vesey, Denmark
Wheatley, Phillis
Wilmot Proviso

Lithograph (1853); Granger Collection

Slaves who picked cotton on plantations in the United States during the 1800's usually worked from sunrise to sunset.

Other related articles

Benin
Cuba (History)
Gorée
Jamaica (History)
Maroons
Palmares
Togo (History)
Toussaint L'Ouverture

Additional resources

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Slavic countries, *SLAH vihk,* are nations where most of the people are Slavs (see Slavs). These countries include the Czech Republic, Poland, Slovakia, and Slovenia in central Europe; Bosnia-Herzegovina, Bulgaria, Croatia, Macedonia, and Yugoslavia in southern Europe; Belarus and Ukraine in eastern Europe; and Russia, which is located partly in eastern Europe and partly in Asia. Sabrina P. Ramet

Slavs, *slahvz,* are any of several groups of peoples, most of whom live in eastern Europe. There are about 275 million Slavs. They speak similar languages, called the Slavic or Slavonic languages.

The first Slavs may have lived more than 5,000 years ago in a region that now forms part of northwestern Ukraine and southeastern Poland. From the A.D. 200's to the 500's, they migrated to other parts of Europe. Some Slavs settled in what is now western Russia and in other parts of eastern and central Europe. Other Slavs migrated to the region of southeastern Europe known as the Balkans.

During the 800's, the Slavs established the Great Moravian Empire, which united the peoples of central Europe for the first time. In 907, the Great Moravian Empire was conquered by the Magyars, the ancestors of the Hungarians. Since then, some of the Slavs have been ruled by a number of foreign powers, including the Byzantine Empire, the Holy Roman Empire, Austria-Hungary, and Germany.

In 1918, after World War I ended, the Slavs established such independent states as Czechoslovakia, Poland, and what later became Yugoslavia. Germany conquered these states during World War II (1939-1945). The Soviet Union dominated most Slavic peoples from its formation in 1922 until its collapse in 1991.

Historians classify the Slavs into three main groups—(1) East, (2) West, and (3) South—based on the region in which these people live.

East Slavs consist of the Belarusians, or White Russians; the Russians, or Great Russians; and the Ukrainians, or Little Russians. The East Slavs were strongly influenced by the culture of the Byzantine Empire (see **Byzantine Empire**). About A.D. 988, the ruler of the East Slavs, Grand Prince Vladimir I, also spelled *Volodymyr,* became an Orthodox Christian. He married a Byzantine princess. Most of the people under his rule also turned to Christianity. Today, many East Slavs belong to Eastern Orthodox Churches.

West Slavs form a group that includes the Czechs; the Slovaks; the Poles; and the Wends, who also are known as Sorbs or Lusatians. The Wends live in eastern Germany. During the 800's, two Greek monks, named Cyril and Methodius, converted many West Slavs to Christianity. At that time, church services were held in Greek or Latin, which few people could understand. But Cyril and Methodius held services in the language of the Slavs, called *Old Church Slavonic.*

As the West Slavs became involved in the affairs of western Europe, they also became influenced by the Roman Catholic Church. Through the centuries, the Catholic Church has strongly influenced western European culture. Today, most West Slavs are Catholics.

South Slavs are a group composed of the Bulgarians, the Croats, the Macedonians, the Serbs, and the Slovenes. During the 800's, many South Slavs were converted to Christianity by followers of Cyril and Methodius. But these Slavs were also strongly influenced by the Byzantine culture. Today, most South Slavs belong to Eastern Orthodox Churches. Most members of the group live in the Balkans. Vojtech Mastny

See the *People* section of the articles on various Slavic countries, such as **Bulgaria** and **Poland**. See also **Russian language**.

Slayton, Donald Kent (1924-1993), was one of the original seven United States astronauts and a member of the first joint space mission with the Soviet Union. On July 17, 1975, Slayton, Thomas P. Stafford, and Vance D. Brand docked their Apollo spacecraft with a Soviet Soyuz spacecraft carrying Alexei A. Leonov and Valery N. Kubasov in orbit around the earth.

Slayton joined the astronaut program in 1959. However, he was removed from active status from 1962 until 1972 because of a minor heart ailment. In 1966, he became director of flight crew operations for the National Aeronautics and Space Administration (NASA) Manned Spacecraft Center (later named the Lyndon B. Johnson Space Center) in Houston. He retired from NASA in 1982. That same year, he became president of a rocket-building company in Houston.

Slayton was born in Sparta, Wisconsin. He entered the United States Air Force (then the Army Air Forces) in 1942 and flew 63 combat missions in World War II. Slayton graduated from the University of Minnesota in 1949. James R. Hansen

Sled is a vehicle that has parallel runners instead of wheels, so that it can move easily over snow or ice. In the Far North, where snow and ice cover the ground for many months of the year, sleds are the chief means of transportation. People in parts of Alaska and Canada's Yukon Territory travel on sleds pulled by huskies.

Alaskan sleds are built to stand the roughest travel. The most common Alaskan sled is the *Nome sledge,* a long, narrow type with basketlike sides. A good team of dogs, hitched to a Nome sledge, can haul 1,000 pounds (450 kilograms) of cargo. The *Nansen* sled, made of wood and lashed with rawhide, is wider and lighter than the Nome sledge. A 30-pound (14-kilogram) Nansen sled can carry a 600-pound (270-kilogram) load. Sleighs called *troikas* are used in Russia. They are drawn by horses or reindeer. In Lapland, reindeer pull sledges carrying heavy goods.

In early times, people made sledges from logs tied together. The sledges were used to haul cargo over both snow and bare ground. Later, people found that the sled would move more easily and quickly if wooden slats, called *runners,* were fastened beneath the logs.

Some North American Indians used a *toboggan* sled that looked like a canoe on a pair of runners. The Pilgrims made sleds from a box set on runners.

After 1870, the *coasting* sled came into use in the United States. The original coasting sled was the "clipper" type. It was built low, with long, pointed sides and runners of round steel rods. The "girl's sled" was a light, short box, with high, cutout or skeleton sides, and wide, flat runners. The *double-runner* or *bobsled* is formed of two clipper sleds joined end to end by a board. The rider steers the sled by means of ropes, a wheel, or a crossbar. Four to 10 people ride in a bobsled. Specially designed bobsleds of steel and fiberglass are used for racing in winter sports events. Robert C. Post

See also **Bobsledding; Luge; Snowmobiling; Tobogganing; Troika.**

Sled dog is a dog used to pull sleds across snow and ice in northern regions. Many purebred dogs—such as the Siberian husky, the Alaskan malamute, and the Samoyed—serve as sled dogs. But crossbred dogs are also widely used, particularly in the United States and

Canada. Sled dogs have long been used as work animals. Today, sled dog racing is a popular sport.

A typical sled dog stands about 2 feet (60 centimeters) high at the shoulder and weighs 40 to 80 pounds (17 to 35 kilograms). It has small pointed ears. A sled dog has a protective outer coat of fur, as well as an undercoat that is often shed in the summer. The undercoat allows these dogs to sleep outside in the snow at temperatures as low as −70 °F (−57 °C).

For more than 1,000 years, native peoples of the Far North have depended on sled dogs for protection, hunting, transportation, and companionship. In the early 1900's, sled dogs helped explorers reach the North Pole and the South Pole. The Royal Canadian Mounted Police patrolled the frontier with sled dog teams from 1873 to 1969. For many years, sled dog teams delivered mail to distant settlements in Alaska and Canada.

The first organized sled dog race took place in 1908 in Nome, Alaska. Today, sled dog races are held in more than 20 countries. In *Nome-style racing,* the dogs in each team are hitched in groups of two side by side, sometimes with a single lead dog. The *musher* (team driver) stands on long runners at the rear of a flexible, wooden sled, often "pedaling" with one foot as if on a skateboard. The musher also may run along at the rear, keeping a firm grip on the sled's handle bar.

In most speed races, the number of dogs on a team is limited to from 3 to 10. A well-trained team averages about 20 miles (30 kilometers) per hour. In long-distance races, teams consist of 10 to 20 dogs. These races cover from 500 to 1,170 miles (800 to 1,900 kilometers). They may take from one to two weeks to complete and involve overnight camping. The sleds must carry from 300 to 600 pounds (135 to 270 kilograms) of food and equipment.

In Europe, *Scandinavian-style racing* is popular. Teams consist of one to three dogs hitched single file with the musher at the rear on skis. The dogs pull weights in either a small sled or a plastic toboggan called a *pulka.* This style is also called *pulka-style racing.*

Critically reviewed by the International Sled Dog Racing Association

See also **Dog** (picture: Working dogs).

Sledge. See Sled.

Sleep is a period of rest during which the sleeper loses awareness of his or her surroundings. Sleep, unlike a coma, is easily ended. A sleeping person or animal can be awakened quickly by, for example, a loud noise or a bright flash of light. All human beings and many kinds of animals must have a certain amount of daily sleep at regular intervals.

What happens during sleep. When a person falls asleep, all activity decreases and the muscles relax. The heartbeat and breathing rate slow down. The person slowly becomes less aware of what may be happening all around.

A sleeping person changes the position of the entire body at least a dozen times during about eight hours of slumber. The head, arms, or legs are moved more often.

Scientists study sleep with an instrument called an *electroencephalograph* (see Electroencephalograph). Whether a person is awake or asleep, the brain gives off electrical waves. An electroencephalograph measures and records these waves. The brain of an awake, relaxed person gives off about 10 small waves a second.

As a person falls deeply into sleep, the brain sends out slower but larger and larger waves. The slowest, largest waves occur during the first two or three hours of a period of sleep. During slow-wave sleep, mental activity slows down but does not stop. Persons awakened from slow-wave sleep can often recall unclear thoughts that they had while asleep.

Periods of small, fast waves, similar to those of an awake person, occur at intervals during sleep. During these periods of fast brain wave activity, the sleeper's eyes move rapidly as though they were watching the events of a dream. A sleeper who is awakened during such a period probably will recall dreaming and remember details of the dream. Sleep during these periods is called *dreaming sleep* or *REM* (*R*apid *E*ye *M*ovement) *sleep.*

An eight-hour period of sleep includes from three to five periods of dreaming sleep. The dreaming sleep periods last from 5 to 30 minutes each and occur every 90 to 100 minutes. The later dream periods last longer than the earlier ones.

Human sleep patterns. Most adults sleep from 7 to $8\frac{1}{2}$ hours every night. Some people, especially those who work at night, sleep during the daytime. Some adults need as little as 6 hours sleep a night—or even less. Others require 9 hours sleep—or even more. Most people need slightly less sleep as they grow older. A person who slept 8 hours a night at 30 years of age may need only 7 hours of sleep at the age of 60.

A person's sleeping patterns develop gradually. Newborn babies sleep for brief periods throughout the day and night. Their sleep periods include dreaming sleep. By the age of 2 or 3 months, babies have learned to sleep through the night, though they nap for periods during the daytime. By the age of 6, most children have given up daytime naps. Four-year-olds average from 10 to 14 hours of sleep a day, and 10-year-olds average from 9 to 12 hours.

Sleep among animals. Scientists study sleeping animals by the same methods that they study sleeping human beings. Among the *vertebrates* (animals with backbones), only reptiles, birds, and mammals experience true sleep, with changes in brain wave patterns. Most kinds of reptiles do not have dreaming sleep periods, and most kinds of birds have only very brief ones. All mammals have periods of dreaming sleep and also periods of slow-wave sleep.

Different species of reptiles, birds, and mammals have different sleep patterns. Some sleep for many short periods every day, but others sleep for one long period. Animals that are *nocturnal* (active at night) sleep during the daytime. Some mammals, such as cattle, can sleep while standing up. However, they dream only while lying down.

The other two groups of vertebrates—fish and amphibians—have periods of what might be called sleep. During these periods, they become less aware than at other times of what is happening around them. But scientists have found no evidence of brain wave changes that suggest sleep among such animals.

Insects, spiders, and other *invertebrates* (animals without backbones) have daily periods of reduced activity. But invertebrates do not show a sudden decrease in responding to their surroundings. No brain changes

have been found to occur during the rest periods of these animals.

What happens without sleep. People deprived of sleep lose energy and become quick-tempered. After two days without sleep, a person finds that lengthy concentration becomes difficult. Through pure determination, a person may perform tasks well for short periods but is easily distracted. Many mistakes are made, especially in routine tasks, and attention slips at times. Every "sleepless" person experiences periods of dozing off for a few seconds or more. The person falls completely asleep unless kept active continuously.

People who go without sleep for more than three days have great difficulty thinking, seeing, and hearing clearly. Some have periods of *hallucinations,* during which they see things that do not really exist. They also confuse daydreams with real life and often lose track of their thoughts in the middle of a sentence.

Human beings have gone without sleep for up to 11 days. But people who have stayed awake so long lose contact with reality for periods of time. They become suspicious and fearful of others. For example, they may believe that a doctor is an undertaker who has come to bury them, or that their food has been poisoned.

The need for sleep. Sleep restores energy to the body, particularly to the brain and nervous system. People require both slow-wave sleep and dreaming sleep. Extra sleep of either kind does not make up for a lack of the other. Slow-wave sleep may help especially in building protein and restoring the control of the brain and nervous system over the muscles, glands, and other body systems. Dreaming sleep may be especially important for maintaining such mental activities as learning, reasoning, and emotional adjustment.

Scientists are still seeking answers to many questions about the need for sleep. They do not know, for example, why human beings cannot simply rest, as insects do. Nor have they discovered exactly how sleep restores vigor to the body. Ernest Hartmann

Related articles in *World Book* include:

Baby (Sleeping conditions)
Dream
Hibernation
Insomnia
Narcolepsy
Nightmare
Sleep apnea
Sleepwalking
Snoring

Additional resources

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Sleep apnea, *AP nee uh,* is a disorder in which pauses in breathing occur during sleep. Symptoms of sleep apnea include snoring, excessive sleepiness during the day, high blood pressure, and heart problems.

The most serious type of the disorder is called *obstructive sleep apnea.* It occurs when suction from breathing pulls the relaxed tongue and throat together and stops air from passing to the lungs. This pause in breathing usually lasts 30 to 60 seconds and lowers the amount of oxygen in the blood. In time, the person awakens and takes several deep gasps, restoring oxygen to the blood. Then the person can fall asleep again. This process may recur hundreds of times a night.

Obstructive sleep apnea often affects overweight, middle-aged men. It may be life threatening if the pauses in breathing affect the heartbeat. However, it can be cured immediately by wearing a special mask over the nose during sleep. This treatment, called *nasal CPAP* (*c*ontinuous *p*ositive *a*irway *p*ressure), keeps the throat passage from closing. Other treatments include losing weight, changing sleeping positions, and surgery on the nose, throat, or jaw. Martin A. Cohn

Sleeping sickness is a disease that attacks the nervous system and often results in a prolonged sleep. It affects human beings and other *vertebrates* (animals with backbones) and is usually fatal if untreated. Sleeping sickness occurs only in Africa and is a serious health problem there for both humans and animals. Its effect on horses and cattle makes raising livestock impossible in some areas of the continent. The disease is also referred to as *African sleeping sickness* or *African trypanosomiasis.*

Cause. Sleeping sickness is caused by several species of single-celled parasites called *trypanosomes.* These organisms have a wormlike shape and a whiplike extension, called a *flagellum,* at one end. The flagellum also extends along one side of the body to form a structure called an *undulating membrane.* A trypanosome moves by waving or whipping the membrane.

The trypanosomes that cause sleeping sickness in humans have the scientific names *T. rhodesiense* and *T. gambiense.* (The *T.* stands for *Trypanosoma.*) The trypanosomes are transmitted by the tsetse fly, an insect that lives along lake shores and riverbanks in Africa. The fly becomes infected with trypanosomes while feeding on the blood of an already infected human or animal. The trypanosomes multiply in the insect's stomach, then pass to the salivary glands. A person becomes infected when bitten by an infected fly.

Sleeping sickness in livestock results from infection by other trypanosomes, including *T. brucei* and *T. congolense.* The trypanosomes are generally transmitted by tsetse flies or other biting insects. One species is transmitted by an infected animal during mating.

Symptoms and diagnosis. The speed at which sleeping sickness develops in people varies with the type of trypanosome involved. In general, *T. rhodesiense* produces symptoms that progress more rapidly than those caused by *T. gambiense.* Most cases of sleeping sickness begin with fever, headache, and chills. These symptoms are followed by swelling of the lymph nodes, skin rash, and weakness. In severe cases, the trypanosomes infect the central nervous system, resulting in uncontrollable sleep, coma, and death.

Doctors diagnose sleeping sickness by examining a sample of the patient's blood, spinal fluid, or lymph. In patients who have the disease, the sample contains trypanosomes, which can be seen under a microscope. Early diagnosis of sleeping sickness is important because prompt treatment can eliminate the parasites and prevent permanent damage to nerve tissues.

Treatment and prevention. Doctors use a variety of drugs to control sleeping sickness in people. The drug suramin is commonly given in the early stages of the disease. If treatment starts before the central nervous system becomes infected, the chances for recovery are excellent. Treatment of sleeping sickness in its later stages is less successful. In addition, trypanosomes tend to develop resistance to the drugs used.

Scientists have done much work on finding methods to control sleeping sickness and its carriers. In some parts of Africa, insecticide sprays have proved effective in eliminating tsetse fly populations. Other control efforts include the use of radiation to make male tsetse flies sterile and therefore unable to reproduce. See **Tsetse fly.** Felipe Kierszenbaum

Sleeplessness. See **Insomnia.**

Sleepwalking, also called *somnambulism,* is a condition during which a partly awakened sleeper performs various physical activities. Most sleepwalkers simply sit up in bed or stand near it. Some actually walk about, but few perform more complicated actions.

Sleepwalking is more common among children than among adults. A person is most likely to sleepwalk during a period of worry or tension. After awakening, most sleepwalkers do not remember their activities. Sleepwalking occurs during deep sleep early in the night. It does not occur during *REM-sleep* (dreaming sleep) and is not associated with dreaming.

Most sleepwalking is harmless. But a sleepwalker may be injured by falling out a window or down stairs or by walking into an obstacle. It does not harm a sleepwalker to be awakened. Ernest Hartmann

Sleet consists of transparent, solid grains of ice that are smaller than 5 millimeters ($\frac{1}{5}$ inch) in diameter. Sleet pellets are spherical or irregular in shape. They are formed by the freezing of raindrops or the refreezing of partly melted snowflakes. The raindrops or melted snowflakes fall from high altitudes in the atmosphere through a layer of below-freezing air near the earth's surface, changing into sleet. When sleet hits a hard surface, it bounces and makes a rapping sound.

A form of precipitation called *graupel* or *snow pellets* is sometimes mistaken for sleet. A graupel pellet forms when cloud droplets hit a snowflake and freeze onto it. Graupel is about the same size and shape as sleet but is white and opaque rather than transparent. In addition, graupel is soft and may disintegrate when it strikes a hard surface. Alexis B. Long

Sleigh. See **Sled.**

Slide. See **Bacteriology** (Studying bacteria); **Microtomy.**

Slide, in photography. See **Photography** (Developing color film); **Projector.**

Slidell, John (1793-1871), a Louisiana Democrat, served as United States commissioner to Mexico in 1845 and Confederate commissioner to France during the American Civil War (1861-1865). In the first of these posts, Slidell became involved in events that led to war between the United States and Mexico. In the second, he became a key figure in an important Civil War incident called the Trent Affair.

As U.S. commissioner to Mexico, Slidell's job was to negotiate for the purchase of New Mexico and California and to try to win Mexican acceptance of the Rio Grande as the boundary between Texas and Mexico. But Mexican leaders refused to meet with Slidell. The United States cited the Mexican refusal as one of its reasons for fighting the Mexican War (1846-1848).

As Confederate commissioner to France, Slidell sailed for Europe, in 1861, aboard a British ship, the *Trent.* His mission was to persuade the French government to support the South. While at sea, a Union warship stopped the *Trent* and seized Slidell and James Mason, the Confederate commissioner to Britain. This action angered the British, and Britain nearly declared war on the Union. The crisis passed after Slidell and Mason were released in 1862. Slidell went on to France. However, he failed to win French support for the Confederacy.

Slidell was born in New York City. He served in the U.S. House of Representatives from 1843 to 1845 and in the U.S. Senate from 1853 to 1861. Michael Perman

See also **Mason, James Murray; Mexican War** (Events leading up to the war); **Trent Affair.**

Slime mold is a tiny, simple fungus that usually grows on decaying wood and moist soil. Slime molds traditionally have been classified in both the animal and plant kingdoms. Today, however, many biologists classify them in the kingdom Fungi.

Like most fungi, slime molds reproduce by means of *spores* (tiny sex cells). The spores are distributed by the wind. Then they germinate and form a simple cell with a single, hairlike attachment called the *flagellum.* With this attachment, the organism swims about. Later, it loses the attachment and several cells unite in a jellylike mass which has the power of slow, creeping movement. This mass, which is called the *plasmodium,* is sometimes 1 foot (30 centimeters) wide. It forms the vegetable body of slime molds. Finally, the plasmodium develops into masses of moldlike spores. The masses are often found on stumps and bark, varying in color from white to orange and red.

Scientific classification. Slime molds belong to the division Myxomycota in the kingdom Fungi. Jerry M. Baskin

Sling is one of the most ancient weapons. It was probably the first weapon designed to hurl a stone with more force than a person could deliver with the hand and arm. In its oldest form, the sling is a leather or hide strap, with a string fastened to each end. A stone or other object is placed on the strap, and the operator holds the two cords. The operator whirls the sling above the head and then lets go of one end of the sling's cord to hurl the stone.

Slings are mentioned many times in the Bible. A most familiar reference is to the slaying of Goliath by David with a stone (I Sam. 17: 49-50).

The ancient people of the Balearic Islands became famous for their skill with the sling. The sling was of great use to the armies of Egypt, Greece, and Rome. During the Middle Ages, soldiers used slings attached to a staff. The soldiers would hurl large stones against fortifications.

In America, a small hand catapult is called a *slingshot,* or *sling.* It is made by fastening an elastic band on each prong of a forked stick, and connecting the elastics by a leather pouch. The pouch holds a stone or small metal bullet. The fork is held in one hand, and the elastic is stretched with the other hand. The shot is hurled when the elastic is released. Such slings can

WORLD BOOK illustration by Sarah Woodward

Roman sling

cause serious injury. Most cities forbid their use.

Bolas are weapons used on the pampas of many South American countries and by the Inuit (sometimes called Eskimos). Bolas are made of stone or balls of clay that are fastened to the ends of rope or cowhide. The free ends are tied or braided together and form a handle. The thrower hurls the bola at an animal. The stones or balls wind the ropes around the animal's legs and throw the animal to the ground. Richard A. Sauers

See also **Indian, American** (picture: Swinging their bolas).

Slipperwort is the name of a group of about 500 species of shrubby and nonwoody plants whose blossoms are shaped somewhat like slippers. They are native to tropical America, but several are grown in hothouses and gardens in temperate parts of North America. Slipperworts have many flowers. Popular species of the plant include the *common slipperwort,* with spotted yellow flowers, and the *bush slipperwort,* which has small yellow flowers.

WORLD BOOK illustration by Lorraine Epstein

Common slipperwort

Scientific classification. Slipperworts belong to the figwort family, Scrophulariaceae. The scientific name for the common slipperwort is *Calceolaria crenatiflora.* The bush slipperwort is *C. integrifolia.*

Michael J. Tanabe

Sloan, John (1871-1951), was an American artist. In 1907, Sloan and other artists formed an informal association of painters called *The Eight* (later called the *Ashcan School* by critics). In his paintings, etchings, and illustrations, Sloan honestly and sympathetically portrayed scenes taken from everyday life. In this manner, he exemplified the artistic philosophy of *The Eight.*

Sloan was born in Lock Haven, Pennsylvania. He first worked as an illustrator for Philadelphia newspapers. He never traveled abroad, but Henri introduced him to the works of the Europeans Frans Hals, Edouard Manet, and Diego Velázquez. These painters influenced Sloan's style. His favorite subjects included city streets, tenements, cafes, and barrooms. Charles C. Eldredge

See also **Ashcan School** (picture).

Sloe, *sloh,* also called *blackthorn,* is a spiny, branching shrub related to the plum. It grows in Europe, Central Asia, and the eastern part of North America. It bears many white blossoms and small black fruits. The fruits are less than $\frac{1}{2}$ inch (13 millimeters) in diameter and are used to make wine, jelly, preserves, and dyes. Sloe gin is a pink liquor that is flavored with sloe. People use sloe branches to make canes and tool handles.

Scientific classification. Sloe is in the rose family, Rosaceae. The scientific name for the sloe is *Prunus spinosa.*

John A. Barden

Slot machine is a mechanical gambling device. Players drop one to five coins into a slot on the front of the machine. They then pull a handle on the side of the machine, causing a group of reels to spin. When the reels stop spinning, various combinations of symbols appear in a glass window on the face of the machine. Players win if the reels produce combinations of two to four identical symbols in a row. A winning combination may be worth from 2 coins to 100 or more. These coins are emptied into a trough at the bottom of the machine. If three or four special symbols are lined up on the reels, the player wins the jackpot. Slot machines may be played only where legally permitted. In 1899, Charles Fey of San Francisco introduced the forerunner of modern slot machines. Dwight Chuman

Sloth, *slawth* or *slohth,* is the common name of a family of South American animals which have a slow and peculiar way of moving. When moving in the trees, they walk upside down, hanging from branches. Sloths can hang so securely with their hooklike claws that they even fall asleep in this position. A sloth may even stay suspended in the trees for some time after it dies.

These strange animals have an odd appearance. They have almost no tails or ears, and their noses are blunt. They have peglike teeth. Their hair is long and coarse. In some species, it is grayish in color, which makes them hard to see among the branches. A sloth asleep looks much like the stump of a bough, especially when it has a growth of green algae on its hair, as many sloths do.

Michael Fogden, Bruce Coleman Inc.

The sloth uses its claws to hang from branches.

Sloths seldom come down to the ground. They feed on leaves, buds, and young twigs. Sloths are abundant in some tropical rain forests. They need relatively little food and have a lower rate of *metabolism* than do other mammals of about the same size. Metabolism is the process by which living things turn food into energy.

There are two main species. One, called the *unau,* has two toes on the front feet. The other, called the *ai,* has three toes on the front feet.

Scientific classification. The sloth makes up the sloth family, Bradypodidae. The common two-toed sloth is *Choloepus didactylus.* The common three-toed sloth is *Bradypus tridactylus.*

Frank B. Golley

See also **Ground sloth.**

Sloth bear, *slawth* or *slohth,* is a big, shaggy animal with a mane of fur around its neck and shoulders. It is also called a *honey bear* because honey is one of its favorite foods. Sloth bears live in the rocky canyons and hills of India and Sri Lanka. They have a short temper and can be dangerous when approached.

The sloth bear is about 5 feet (1.5 meters) long and

weighs up to 250 pounds (113 kilograms). It has long black fur with a light-colored U-, V-, or Y-shaped patch on the chest. The sloth bear's face is gray and almost hairless.

Sloth bears usually eat termites and the *larvae* (grubs) of bees. They also eat flowers, leaves, fruits, and grain. They will climb anywhere to get at nests of termites or bees. They use their big feet and long claws to rip open termite nests and open tree trunks and branches that hold honeycombs. At a termite nest, they blow away the dust to expose the termites and then suck the insects into their mouths. The sloth bear's lips, tongue, and teeth are well suited to its feeding habits. It has a long snout, flexible lips, and a long, sticky tongue. Its two front teeth are missing in both the upper jaw and lower jaw. The bear draws in its food through this cavity with loud sucking noises.

E. Hanumantha Rao, Photo Researchers

The sloth bear has shaggy black fur and a gray, almost hairless face. These bears live in the hills of India and Sri Lanka.

Sloth bears hunt for food at night. During the day they sleep in protected places, usually in caves along riverbanks. They do not sleep for long periods in the winter as some bears do. Most female sloth bears give birth to one or two cubs at a time. The cubs often ride on their mother's back, even when the mother climbs trees.

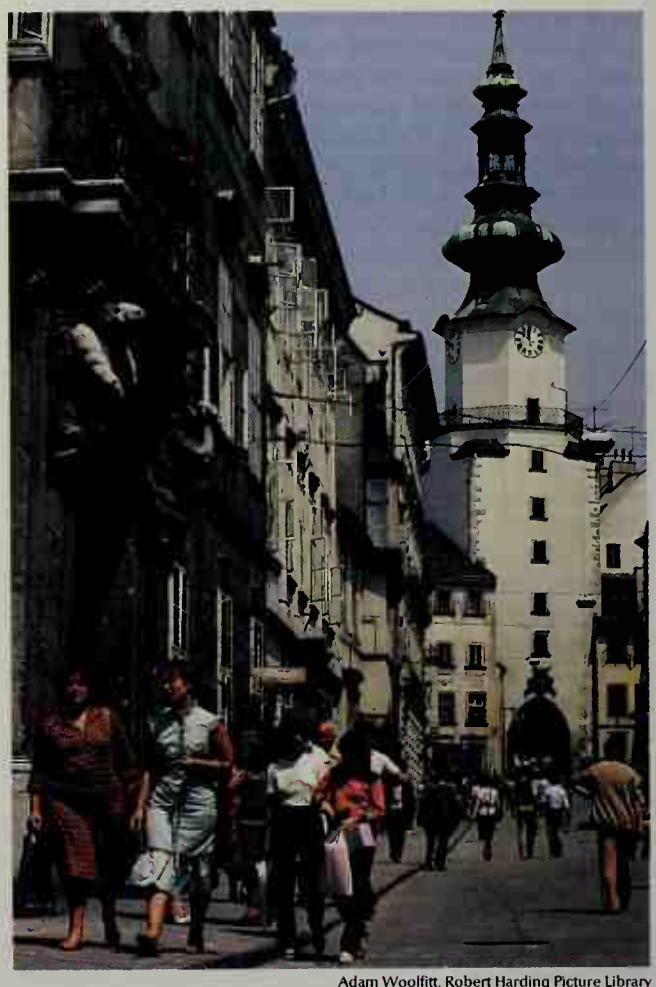
Gregory K. Snyder

Scientific classification. Sloth bears are in the bear family, Ursidae. They are genus *Melursus* and species *M. ursinus*.

Slovakia is a country in central Europe. It is bordered by Poland on the north, Ukraine on the east, Hungary on the south, and Austria and the Czech Republic on the west. Mountain ranges cover most of the country.

Bratislava is the capital and largest city of Slovakia. A Slavic people called Slovaks make up most of the country's population. Hungarians make up the second largest ethnic group in Slovakia.

For much of its history, Slovakia formed part of larger states. Hungary ruled the country from the 900's until 1918. That year, the Slovaks joined with the Czechs and with other local groups to form the country of Czechoslovakia. In 1948, Communists took over Czechoslovakia's government. In 1989, following protests by large numbers of Czechs and Slovaks, the Communist government resigned and non-Communists came to power.



Adam Woolfitt, Robert Harding Picture Library

Bratislava, Slovakia's capital, is a major cultural and manufacturing center. The old section of the city, *shown here,* has many churches and other buildings from the 1300's and 1400's.

Soon afterward, the Czechs and Slovaks began to disagree about important economic and political issues. In mid-1992, Czech and Slovak leaders decided to split Czechoslovakia into two nations, one for Czechs and one for Slovaks. On Jan. 1, 1993, the Czech Republic and Slovakia were created to replace Czechoslovakia.

Facts in brief

Capital: Bratislava.
Official language: Slovak.
Official name: Slovenská Republika (Slovak Republic).
Area: 18,924 mi² (49,012 km²). *Greatest distances*—east-west, 260 mi (418 km); north-south, 130 mi (209 km).
Elevation: *Highest*—Gerlachovský Štít, 8,711 ft (2,655 m) above sea level. *Lowest*—308 ft (94 m) above sea level, near the Bodrog River on the Hungarian border.
Population: *Estimated 2002 population*—5,404,000; density, 286 persons per mi² (110 per km²); distribution, 57 percent urban, 43 percent rural. *1991 census*—5,274,335.
Chief products: *Agriculture*—barley, corn, livestock, potatoes, sugar beets, wheat. *Manufacturing*—ceramics, chemical products, machinery, petroleum products, steel. *Mining*—coal.
Flag: The flag has horizontal stripes of white, blue, and red. The national coat of arms appears on the left side of the flag. See **Flag** (picture: Flags of Europe).
National anthem: "Nad Tatrou sa blyská" ("Lightning Flashes over the Tatra").
Money: *Basic unit*—koruna. One hundred halierov equal one koruna.

Government

Slovakia is a parliamentary democracy. A one-house parliament called the National Council makes the country's laws. Voters elect the 150 members to four-year terms. A president serves as head of state. The people elect the president to a five-year term. The president appoints a prime minister, who serves as head of government. The prime minister is usually the head of the party with the most seats in parliament. The president also appoints a cabinet on the advice of the prime minister. The cabinet helps the prime minister carry out the executive functions of the government. The prime minister has executive authority in the government.

Numerous political parties are active in Slovakia. The Movement for a Democratic Slovakia, a left-of-center group, is the most popular political party. The second strongest group is the Slovak Democratic Coalition, which includes several parties. The Party of the Democratic Left and the Hungarian Party are also active.

The Supreme Court is Slovakia's highest court. Parliament elects the Supreme Court judges.

About 50,000 soldiers make up Slovakia's armed forces. Men must serve 12 months in the military after reaching age 18. Women enlist on a voluntary basis.

People

Ethnic groups and languages. Slovaks make up the majority of Slovakia's population. People of Hungarian descent form the second largest ethnic group. Smaller numbers of Czechs, Germans, Poles, Russians, and Ukrainians also live in Slovakia. Gypsies, mostly of the Rom group, make up a substantial minority.

Slovak is Slovakia's official language. Czech, German, Hungarian, and Polish are also spoken. The Gypsies speak Romany, which belongs to the Indo-Iranian group of languages. Since the end of Communist rule, tensions have surfaced between Slovaks and the Hungarian minority over language and cultural issues.

Way of life. More than half of Slovakia's people live in towns and cities. The largest cities include Bratislava, Košice, Nitra, Prěsov, and Žilina. Many urban residents live in high-rise apartments constructed during the Communist period. Most rural families live in single-family houses.

The standard of living is higher in Slovakia than in many other formerly Communist countries in Europe. Most families own automobiles, refrigerators, televisions, and washing machines. Many city families have weekend cottages in the country.

The lifting of political controls and the opening of borders after the end of Communist rule have caused an increase in crime and drug abuse in Slovakia. Air and water pollution are serious threats in many parts of the country, especially in the cities.

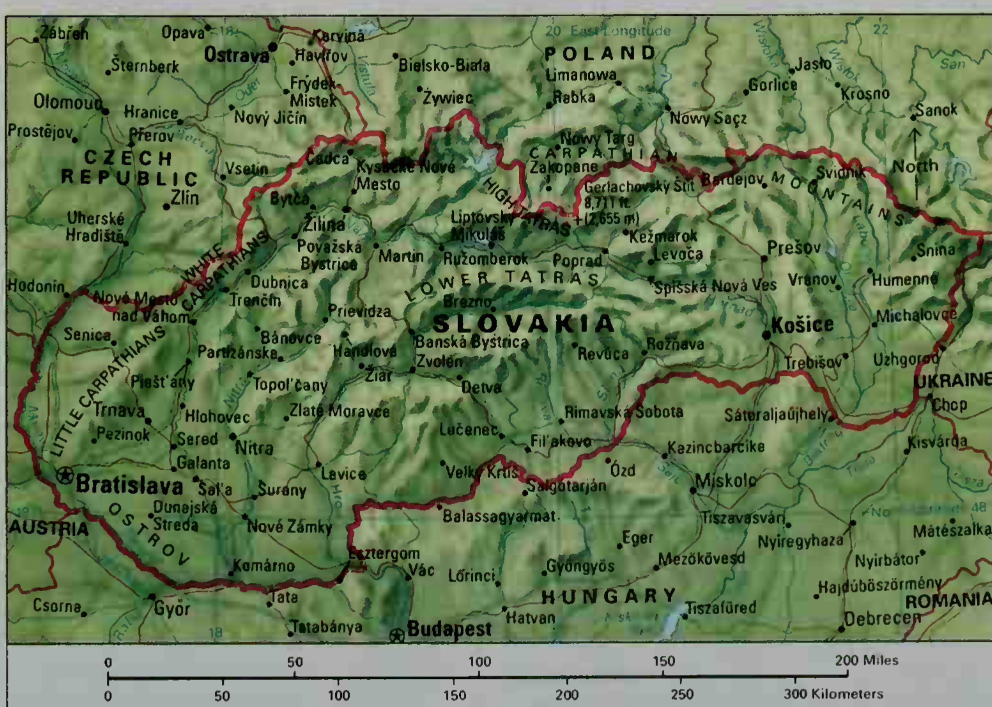
Food and drink. *Bryndzove halušky* (noodles with sheep's cheese) is a typical Slovak dish. A paprika-flavored stew called *goulash* and other Hungarian dishes are also popular. Wine and a plum brandy called *slivovice* are common alcoholic beverages.

Recreation. Slovakia's people enjoy a variety of leisure activities. Many people attend soccer matches and other sporting events. Skiing is also popular. City residents often spend their evenings socializing with friends in wine cellars or attending ballets, concerts, operas, or plays. Many families enjoy camping, hiking, and mountain climbing.

Religion. Most people in Slovakia are Roman Catholics. Most Protestant denominations and an Eastern Orthodox group called the Orthodox Church of the Czech Lands and Slovakia are also active. The country has a small Jewish population. Most of Slovakia's Jews were killed by the Nazis during World War II (1939-1945).

Education. Almost all adults in Slovakia can read and write. Children are required to attend eight years of elementary school and two years of secondary school. Comenius University in Bratislava is Slovakia's leading university. Košice, Prešov, and Trnava also have universities.

Slovakia



WORLD BOOK maps

CTK/Eastfoto

A worker assembles a tractor in a factory in Martin. Manufacturing is important to the economy of Slovakia. About one-third of the country's workers hold jobs in factories.

The arts. Folk art has a long tradition in Slovakia. The best-known objects made by folk artists are baskets, glass paintings, pottery, and woodcarvings. Painted wooden houses and other forms of folk architecture are found in many regions, including the Ukrainian villages of eastern Slovakia.

Land and climate

A series of mountain ranges, part of the western branch of the Carpathian Mountains, covers most of Slovakia. The Little Carpathians and the White Carpathians dominate much of western and northwestern Slovakia. A range called the High Tatras extends along part of the country's northern border. Gerlachovský Štít, Slovakia's highest peak, rises 8,711 feet (2,655 meters) in this range. The great beauty of the High Tatras has made the area a favorite vacation spot. It is also a national park. The industrial city of Košice lies at the foot of the Carpathians.

The Danubian Lowlands make up southwestern Slovakia. The Danube River forms the southern boundary of this region. The lowlands are a fertile farming region. Farmers raise corn, wheat, and hogs there. Bratislava is the area's main industrial center.

Several rivers wind through Slovakia, including the Danube, the Hornád, the Hron, and the Váh. Fir and spruce trees cover many of the country's mountains. Beeches, birches, lindens, and oaks grow in lower areas. Foxes, muskrats, rabbits, squirrels, and weasels inhabit the forests. Wild boars, wolves, and other wild animals roam remote mountain slopes.

Slovakia's climate varies greatly with elevation. Temperatures range from a low of 14 °F (−10 °C) in January to a high of 68 °F (20 °C) in July. Slovakia receives from 24 to 40 inches (60 to 100 centimeters) of rain, snow, and other forms of moisture annually.

Economy

Slovakia had been an agricultural region for most of its history but became industrialized under Communist rule. Czechoslovakia's Communist government centralized the economy after it came to power in 1948, taking control of almost all the country's land and businesses. The Communists emphasized heavy industry, such as the manufacture of machinery and steel. Slovakia became the center of Czechoslovakia's weapons industry. Other industries that developed in Slovakia were ceramics, footwear, petroleum refining, timber, and textiles.

After the Communist government left office, Czechoslovakia's new leaders took steps toward establishing an economy based on free enterprise. In a free enterprise economy, businesses operate without extensive government control. Many private businesses were established in Slovakia. Most of them were in construction, manufacturing, and retail trade and other service industries. Additionally, many state-owned businesses became privately owned. Today, most businesses in Slovakia are privately owned. The economic changes initially produced hardship. But Slovakia's economy began to recover by the mid-1990's and steadily improved.

Service industries and manufacturing form the backbone of Slovakia's economy. Service industries employ about half of the country's workers. The service sector has developed rapidly since the end of Communist rule. About a third of Slovakia's work force holds jobs in manufacturing. Slovakia's leading manufactured products include ceramics, chemical products, machinery, petroleum products, and steel. Bratislava and Košice are the country's main industrial centers. The weapons industry is concentrated in Martin.

Agriculture employs about a tenth of the workers of Slovakia. Barley, corn, potatoes, sugar beets, and wheat are Slovakia's primary crops. Farmers grow wine grapes on the southern slopes of the High and Low Tatras and in southern Slovakia. Fruit and tobacco grow in the Váh River Valley. Slovak farmers also raise a good deal of livestock, including cattle, hogs, and sheep.

Mining and energy. Slovakia's main mineral resources are copper, iron, lead, manganese, and zinc. Brown coal deposits lie near Handlová and Velký Krtíš.

Hydroelectric plants are an important source of energy in Slovakia. There are hydroelectric plants on the Danube, Hornád, Orava, Slaná, and Váh rivers.

Trade. Slovakia's chief exports include chemical products, petroleum products, steel, and weapons. Crude oil, natural gas, and electronic products are the main imports. Austria, the Czech Republic, Germany, Hungary, Poland, and Russia are Slovakia's main trading partners.

Transportation and communication. Slovakia has about 11,400 miles (18,300 kilometers) of roads. Railroads link all the major cities and many smaller towns. Bratislava has an international airport.

Slovakia has about 20 daily newspapers and about 570 magazines and journals. The country has both state-owned and privately owned television stations.

History

Early days. Slavic tribes settled near the Danube River in what is now Slovakia in the A.D. 400's and 500's. In 623, Slovakia became part of an empire founded by Samo, a former merchant of a Germanic people known as the Franks. In the 800's, Slovakia became part of the Great Moravian Empire established by a ruler named Mojmír. The empire also included Bohemia and Mora-

via, two main regions in what is now the Czech Republic. Hungarian tribes conquered the empire in 907. Hungary then ruled Slovakia for nearly 1,000 years.

Hungarian rule. A period of religious wars began in Bohemia and Moravia in the 1400's. Many Czech nobles fled Bohemia and Moravia and settled in Slovakia. From 1438 to 1453, a Czech noble controlled much of southern Slovakia. The Ottomans defeated Hungary in the Battle of Mohács in 1526 and occupied central and eastern Hungary soon afterward. Slovakia became the cultural and political center of what remained of Hungary. But the Slovaks, most of whom were peasants, held no political power in the state.

During Hungarian rule, the Slovaks were pressured to give up their culture and language and become Hungarian. Beginning in the late 1700's, Slovak religious leaders tried to create a sense of national identity among Slovaks. Until that time, Slovak writers had used Czech, German, or Hungarian for their literary works. Anton Bernolák, a Roman Catholic priest, developed a Slovak literary language based on western Slovak dialects. Jan Kollár and Pavol Šafařic, two Slovak Protestants, developed a form of the Slovak language that combined Czech and central Slovak dialects. But Hungarian control prevented the growth of a large nationalist movement among Slovaks. In 1867, Austria and Hungary formed a monarchy called Austria-Hungary.

The formation of Czechoslovakia. At the end of World War I (1914-1918), Austria-Hungary collapsed, and the Czechs and Slovaks united to form the new nation of Czechoslovakia. Slovakia's economy was much less developed than those of Bohemia and Moravia. The Slovaks also had less experience in self-government than the Czechs did. Thus, the Czechs controlled Czechoslovakia's economy and government. Efforts to industrialize Slovakia failed, due in part to the Great Depression, the worldwide economic slump of the 1930's. Many Slovaks grew dissatisfied with Czech control, and support for extreme nationalist movements grew.

World War II. In 1938, Hungary forced Czechoslovakia to give up several areas that had large Hungarian populations, including the city of Košice. These areas were along the border of Slovakia and Hungary. On March 14, 1939, faced with the threat of being divided between Germany, Poland, and Hungary, Slovakia declared its independence. Jozef Tiso, a Roman Catholic priest, was elected president. German troops occupied Czechoslovakia the following day, and Slovakia came under German influence. In September, World War II broke out. In 1944, several Slovak resistance groups fought against German control in the Slovak National Uprising.

Communist rule. At the end of the war in 1945, Slovakia once again became part of Czechoslovakia. Tiso was convicted of treason and cooperating with the Germans. He was hanged, and other high-ranking officials were punished. From 1945 until 1948, Communists and members of other political parties ruled Czechoslovakia in a coalition government. In February 1948, the Communists staged a political crisis and took over the government.

The Communist government patterned the country's economy and political structure after those of the Soviet Union. The state took control of the country's factories and almost all the other businesses. Farmers were forced to join government-owned state farms or *collectives,* in which the farmworkers jointly owned the property and farm equipment. The government silenced opposition to the Communist Party and took steps to decrease the influence of churches.

The 1960's. In the late 1960's, many Slovak Communist Party leaders and intellectuals took part in a movement to reform the Communist system. The movement tried to create what came to be known as "socialism with a human face." It was led by Alexander Dubček, a Slovak who became head of the Czechoslovak Communist Party in January 1968. However, leaders in the Soviet Union and other European Communist nations feared that Dubček's program would weaken Communist control in Czechoslovakia. As a result, troops led by the Soviet Union invaded Czechoslovakia on Aug. 21, 1968.

Gustáv Husák, another Slovak, replaced Dubček as head of the Czechoslovak Communist Party in April 1969. Other leaders of the reform movement also lost their positions. The Husák government eliminated most of the reforms and reestablished tight political controls and censorship of the press. However, a 1968 amendment to the Constitution granted Slovakia slightly greater powers of self-government.

The Velvet Revolution. In November 1989, Czechs and Slovaks gathered in the streets to demand changes in the government and greater political, economic, and civil freedoms. Less than a month later, Czechoslovakia's Communist government resigned, and non-Communists gained control of the government. Communist rule in Czechoslovakia was replaced so smoothly and peacefully that it became known as the *Velvet Revolution.*

The first free elections since 1946 were held in June 1990. In the elections, non-Communists won a majority of seats in the legislature. The new government began working to create a free enterprise economy and to reverse the policies of the Communist era. However, tensions between Czechs and Slovaks slowed economic reform and prevented the adoption of a new constitution.

Czech and Slovak leaders disagreed about how quickly a free enterprise economy should be created. The Slovaks wanted the state to keep a greater role in the economy than the Czechs did. Also, the moves toward a free enterprise economy caused more hardship and unemployment in Slovakia than they did in the Czech areas. As a result, support for nationalist parties and political leaders increased among Slovaks.

The breakup of Czechoslovakia. In parliamentary elections held in June 1992, the Movement for a Democratic Slovakia, a left-of-center party led by Vladimír Mečiar, won a majority of seats in Slovakia's parliament. Václav Klaus's Civic Democratic Party, a center-right group, won a majority of seats in the parliament of the Czech Republic. Although most Czechs and Slovaks wanted to remain united, Mečiar and Klaus began to arrange for the breakup of Czechoslovakia. On Jan. 1, 1993, the independent nations of Slovakia and the Czech Republic were formed, and the nation of Czechoslovakia ceased to exist.

Sharon L. Wolchik

Related articles. See the articles on Czech Republic and Czechoslovakia and their lists of *Related articles.* See also:
Bratislava
Carpathian Mountains
Hungary (History)
Košice

Slovenia, *sloh VEE nee uh,* is a small, mountainous country in central Europe that declared its independence in 1991. In 1918, Slovenia became part of the Kingdom of the Serbs, Croats, and Slovenes, later renamed Yugoslavia. In 1946, Yugoslavia became a federal state consisting of six republics, one of which was Slovenia.

Ljubljana, Slovenia's capital and largest city, is the center of cultural and political life in the nation. Other important towns in Slovenia are Maribor, the second largest city, and the port city of Koper.

Slovenes make up almost all of Slovenia's population. Most of the other residents of Slovenia are ethnic Croats, Serbs, or Hungarians. A small number of Italians, as well as members of other nationalities, also live in Slovenia.

Tourists visit Slovenia throughout the year. The mountains have ski resorts and beautiful lakes, and the short coastline has sunny beaches that attract many vacationers. In addition, tourists go to see the caves at Postojna, located near Ljubljana, which are the largest caverns in Europe.

Another tourist attraction is the village of Lipica, near the Italian border in southwestern Slovenia. For more than 400 years, Lipizzaner horses have been raised at a farm in this village for the Spanish Riding School of Vienna, Austria.

From 1945 to 1990, Communists held a monopoly on power in all of Yugoslavia, including Slovenia. In 1990, Slovenia held elections in which non-Communists won a majority of seats. The republic declared its independence in 1991.

Government. A one-house National Assembly makes Slovenia's laws. The voters elect the 90 members of the National Assembly to four-year terms. The government also has a 40-member Council of State, which has no legislative authority but may propose laws or ask the National Assembly to reconsider a vote. Council members serve five-year terms. The Assembly elects a prime minister to head the government. The prime minister serves a four-year term. The voters elect a president to a five-year term, but the office is largely ceremonial. All citizens 18 years old or older can vote.

Slovenia adopted its first constitution as an independent state in December 1991. The Constitution guarantees freedom of speech, assembly, press, and religion, as well as other civil rights.

The most important political parties in Slovenia are the Liberal Democratic Party, the Slovenian Christian Democrats, the Associated List (a coalition of four parties), the Slovenian National Party, and the Slovenian People's Party.

The highest court in Slovenia is the Supreme Court. The Assembly appoints all judges in Slovenia.

About 15,000 men and women make up Slovenia's armed forces. The government drafts men at age 18 for seven months of military service but is required to re-

Facts in brief

Capital: Ljubljana.
Official language: Slovenian.
Official name: Republika Slovenija (Republic of Slovenia).
Area: 7,821 mi² (20,256 km²). *Greatest distances*—north-south, 100 mi (160 km); east-west, 155 mi (250 km).
Elevation: *Highest*—Mount Triglav, 9,393 ft (2,863 m) above sea level. *Lowest*—sea level along the coast.
Population: *Estimated 2002 population*—1,982,000; density, 253 per mi² (98 per km²); distribution, 50 percent rural, 50 percent urban. *1991 census*—1,965,986.
Chief products: *Agriculture*—apples, cattle, cherries, corn, hogs, pears, plums, potatoes, sheep, sugar beets, wheat. *Manufacturing*—automobiles, chemicals, metal goods, textiles. *Mining*—coal, lead, mercury.
Flag: The flag has horizontal stripes of white, blue, and red. The national shield is on the white and blue stripes in the upper left corner. See **Flag** (picture: Flags of Europe).
National anthem: "Zdravljica" ("The Toast").
Money: *Basic unit*—tolar. One hundred stotin equal one tolar.

© Tom Sobolik, Black Star

Slovenia is a mountainous country in central Europe. Small rural villages dot its countryside. About half of the people of Slovenia live in rural areas.

lease servicemen when there is no national emergency.

People. About 90 percent of the people are Slovenes, a Slavic people who speak Slovenian. Slovenian is written in the Roman alphabet, not the Cyrillic system of writing used for many Slavic languages. Most Slovenes also speak another language, usually German, Italian, Serbo-Croatian, or English. Most Slovenes are Roman Catholics, though some belong to Protestant churches.

About half of the people live in rural areas. Rural families usually live in single-family homes with steep roofs. Many city dwellers live in high-rise apartment buildings.

Slovenian cooking resembles that of Austria. Veal and pork are favorite meats. One of the best-known Slovenian dishes is *Ljubljana veal cutlet,* breaded slices of veal served with a cheese sauce. Slovenia produces some excellent wines.

Nearly all adults can read and write. Children are required to attend eight years of elementary school and four years of secondary school. Slovenia has two universities and many other institutions of higher education.

Slovenia has produced many fine writers. Primož Trubar is considered the father of Slovenian literature. He wrote several religious works and translated the New Testament into Slovenian during the 1500's. France Prešeren was an important lyric poet of the 1800's. Ivan Cankar was one of the best Slavic short-story writers of the early 1900's. Important writers of the late 1900's included Andrej Hieng, Drago Jančar, Ciril Kosmač, Tomas Salamun, and Rudi Šeligo.

Festivals play an important part in Slovenian life. Every February, the town of Ptuj in northeastern Slovenia holds a *Kurenti* festival, a celebration that dates from the pre-Christian era. During the festival, people dress up in animal masks and furs and perform rituals designed to drive away the "evil spirits" of winter.

Land and climate. Mountains make up much of Slovenia, and thick forests cover about half the land. The Julian Alps lie in Slovenia's northwest corner. Slovenia's highest point, Mount Triglav, rises 9,393 feet (2,863 meters) in this range. The mountains are home to many types of game animals, such as small antelopes called *chamois.* Hilly plains spread across central and eastern Slovenia. The central part of the country also includes a limestone region called the *Karst.* The Karst is characterized by caves and underground channels that cause rainwater and even lakes to appear and disappear. A small strip of coastline lies along the Adriatic Sea.

© Steve McCurry, Magnum

Workers inspect electronic circuit boards in a factory near Ljubljana, Slovenia's chief manufacturing center. Almost half of the workers in Slovenia hold jobs in manufacturing.

WORLD BOOK maps

Slovenia's climate varies greatly from region to region. The mountains have exceptionally cold winters with much snow. Heavy rains fall in early summer. Summers are warm in the mountain valleys but cooler at higher elevations. The coastline has a mild climate. The temperature rarely falls below freezing in winter, and summers are hot and dry. Northeastern Slovenia has cold winters and hot summers. Temperatures can get as high as 100 °F (38 °C) in the summer and frequently fall below freezing in the winter.

Economy. When Slovenia was part of Yugoslavia, it had the strongest economy of the six republics. But Slovenia's economy lagged under Communism, especially during the 1980's. After non-Communists came to power in 1990, Slovenia began to establish a free enterprise system, in which businesses could operate without extensive government control.

About 46 percent of the workers are employed in service industries, and another 46 percent hold jobs in manufacturing. About 8 percent work in agriculture.

The leading manufactured products include automobiles, chemicals, metal goods, and textiles. The most important crops are corn, potatoes, and wheat. The major

fruits grown in Slovenia are apples, cherries, pears, and plums. Farmers also raise cattle, hogs, and sheep. Mines yield coal, lead, and mercury. Slovenia's major trading partners are Austria, Germany, and Italy.

Slovenia has many good roads, especially those linking the country with Austria and Italy. Railroads serve the main cities and towns. Ljubljana has an international airport. Koper is Slovenia's only commercial port.

The leading daily newspapers in Slovenia are *Delo* and *Dnevnik*. Both are published in Ljubljana.

History. During the A.D. 500's, a people called the Lombards lived in present-day Slovenia. At that time, the Lombards left Slovenia and resettled in Italy. During the late 500's, the Slovenes, the westernmost branch of a people known as the *South Slavs,* settled in Slovenia.

The Slovenes were ruled by a people called the Avars until 623. That year, Samo, a former merchant of a Germanic people known as the Franks, drove out the Avars and established an independent Slovenian state. In 748, the Slovenes came under Bavarian-Frankish rule. In 1278, the Habsburgs (also spelled Hapsburgs), an Austrian royal family, gained control of Slovenia. Slovenia remained under Austrian rule until 1918, except for a period of French control that lasted from 1809 to 1815.

After World War I ended in 1918, Slovenia became part of a new state called the Kingdom of the Serbs, Croats, and Slovenes. The name of the country was changed to Yugoslavia in 1929. In 1941, during World War II, Germany and Italy conquered Slovenia and divided it among themselves and Hungary. After the war ended, the Communists came to power in Yugoslavia, and Slovenia became one of the country's six republics.

During the late 1960's and early 1970's, some Slovenes called for the republic to *secede* (withdraw) from Yugoslavia. But in 1972 and 1973, Yugoslav president Josip Broz Tito eliminated the liberals from the Slovenian Communist Party. With this move, Tito tried to secure Slovenia more tightly to Yugoslavia.

In 1990—as Communism collapsed throughout Eastern Europe—the Communists voted to end their monopoly on power in Yugoslavia. Numerous non-Communist political parties began to form. In April 1990, Slovenia held its first multiparty elections.

In June 1991, Slovenia and another Yugoslav republic, Croatia, declared their independence. The Yugoslav government strongly opposed the declaration. Some fighting took place between the Slovene militia and the Yugoslav military. In December, Slovenia's Assembly approved a new constitution.

In late 1991, the Yugoslav republic of Macedonia declared independence. Bosnia-Herzegovina did so early in 1992. In April 1992, Serbia and Montenegro established a new Yugoslavia and thus seemed to recognize the independence of Slovenia and the other republics. Also in April, the National Assembly elected Janez Drnovšek, head of the Liberal Democratic Party, as prime minister.

The Assembly reelected Drnovšek in 1997 and again in 2000. Beginning in the late 1990's, Slovenia worked toward joining the European Union—an economic and political coalition—and the North Atlantic Treaty Organization—a defense alliance. Sabrina P. Ramet

See also Ljubljana; Yugoslavia (History).

Slowworm. See Blindworm.

Slug is a kind of snail that usually has no shell. Some slugs possess a small, flat shell on or under the skin. For protection, they secrete a thin layer of bad-tasting slime. Slugs have both male and female sex organs. They usually mate in pairs but can reproduce without mating.

There are two kinds of slugs—*land slugs* and *sea slugs*. Land slugs may have white, gray, yellow, or brown bodies. They range in size from $\frac{1}{4}$ inch (0.6 centimeter) to about 4 inches (10 centimeters) long. Most have *tentacles* (feelers) with eyes at the tips. Land slugs can become garden pests because they feed on plants. Some species eat fungi, insects, earthworms, animal waste, or other slugs. Land slugs will dry out in sunlight, and they usually spend the day hiding underground or beneath damp objects. Sea slugs live in the sea and often have colorful bodies. They eat seaweed or marine animals, such as sponges. Robert Robertson

Charles W. Mann, National Audubon Society from Photo Researchers

A slug is a kind of snail that moves by sliding on a thin coating of slime. The animal secretes the slime from its body.

Scientific classification. Slugs belong to the class Gastropoda, in the phylum Mollusca. Land slugs are members of the subclass Pulmonata. Sea slugs are in the subclass Opisthobranchia.

See also Snail.

Slum. See Housing; Urban renewal.

Small Business Administration (SBA), an independent agency of the United States government, promotes and protects the interests of small business companies. It offers aid in the form of loans, counseling, and information on management. The SBA helps victims of disasters and provides programs to enable members of minority groups and women to own their own businesses. It ensures that small businesses receive a fair share of government purchases and contracts. The SBA issues more than 800 publications in various fields of small business. It has offices in principal cities of every state and in Guam and Puerto Rico. Congress created the SBA in 1953. Critically reviewed by the Small Business Administration

Small-claims court is a city or state court that handles minor lawsuits involving claims ranging up to $5,000. Small-claims courts aim to solve such cases speedily, efficiently, and cheaply.

Small-claims lawsuits intend to help citizens who want to collect small debts or claim damages for what they consider faulty products or poorly performed services. Actually, however, most small-claims lawsuits in-

volve a business or public utility that wants to collect payment from customers for unpaid bills.

Small-claims courts handle their cases without many of the costly and formal procedures of other courts. For example, individuals can plead their own case without hiring a lawyer. The court also conducts its proceedings in everyday language and avoids technical legal terms. Most small-claims courts do not provide the right to a trial by jury nor the right to appeal the ruling.

A small-claims lawsuit begins when the plaintiff files a complaint. The court then orders the defendant to appear in court to respond. The plaintiff and the defendant each briefly argue their side of the case. Then the judge or an appointee of the court issues a ruling.

The first small-claims court was established in 1913 in Cleveland. By 1916, many states had set up small-claims courts. Today, every state has a small-claims court or a court that handles small claims. Sherman L. Cohn

Smallpox has been one of the most feared diseases in history. Scientists believe that, in the 1900's alone, smallpox killed more than 300 million people. It scarred and blinded millions more. Smallpox is also the first and only disease completely *eradicated* (eliminated) from nature by human beings.

Smallpox was caused by a virus called *Variola major*. It spread from person to person through the air. A smallpox victim expelled droplets containing the virus from the nose and mouth. Another person inhaled the droplets and became infected. In most cases, aches and a high fever appeared in the new patient 10 to 12 days later. Two to four days later, a rash appeared on the face and spread to other parts of the body. The rash resembled thousands of small pimples. The pimples—called *pustules*—soon became larger, painful, and filled with pus. Historically, the pustules were called *pox*, leading to the name smallpox. In the following days, scabs would form over the pustules. The scabs eventually fell off three or four weeks later.

In 1796, British physician Edward Jenner developed the first vaccine—one that prevented smallpox. Its use quickly spread to other parts of the world. The disease continued to exist almost everywhere until the 1940's, when it was eliminated in Europe and North America by use of an improved vaccine. The last case of smallpox in the United States occurred in 1949. Until 1971, most children in the United States were vaccinated as infants and again after five years.

In 1967, the World Health Organization (WHO) began a program to eradicate smallpox. At that time, the disease still occurred in Africa, Asia, and South America. WHO vaccination teams traveled from village to village and searched from home to home for smallpox cases. Infected people were isolated, and everyone who had been in contact with them was vaccinated. The last known case of naturally occurring smallpox was found in Somalia in October 1977. In 1980, WHO formally announced that smallpox had been eliminated, and vaccination throughout the world was stopped.

While the disease was eliminated in nature, many laboratories still had stocks of smallpox virus. A WHO committee recommended that all laboratories destroy their stocks or transfer them to one of two laboratories in the Soviet Union (now Russia) and the United States. But stocks of smallpox virus in the Soviet Union were used to create biological weapons. The Russian government has since ended such biological weapons programs.

Historians believe that in 1763 smallpox was used as a biological weapon by British forces in North America during the French and Indian wars (1689-1763). They distributed blankets that had been used by smallpox victims to cause outbreaks among Indians. Devastating epidemics occurred in the years that followed. Experts in the United States believe that the deliberate use of smallpox virus as a biological weapon remains possible. In 2000, the United States began a program to develop and store smallpox vaccine for such an emergency.

Thomas V. Inglesby

See also Jenner, Edward.

Smalls, Robert (1839-1915), was an African American who became a Union hero in the American Civil War (1861-1865). He later had a successful political career.

Smalls was born into slavery on April 5, 1839, in Beaufort, South Carolina. He became an expert pilot on boats in and around Charleston (South Carolina) Harbor. The Civil War gave him the chance to win his freedom. In 1861, the Confederacy forced Smalls to pilot the *Planter*, a messenger and transport steamer. In 1862, he guided the ship out of Charleston Harbor and delivered it to Union officials. He then piloted the *Planter* for the Union. He served in the South Carolina Legislature from 1868 to 1875, and in the U.S. House of Representatives from 1875 to 1879 and from 1882 to 1887. Richard Bardolph

Smart card is a plastic card embedded with at least one computer chip. Such chips store information and may also perform mathematical calculations. Smart cards are used with many electronic devices, including automated teller machines (ATM's), cellular telephones, and handheld computers.

Some people refer to cards that store information on a magnetic stripe as "smart" cards. However, the International Organization for Standardization (ISO), an association that sets standards of quality to help world trade, regards only cards with a computer chip as smart cards. Smart cards can store much more information than magnetic-stripe cards can. A magnetic-stripe identification card might hold a person's name, address, Social Security number, and insurance information. A smart identification card could also store a person's fingerprints and keep track of drug prescriptions.

Some smart cards store a money value that can be used for purchases. Such cards can then have value returned to them by electronic transfers from a bank account. Smart cards used with handheld computers might hold an electronic dictionary, a tiny modem that enables the computer to communicate with other computers, or a specialized computer program. Some smart cards are used as security devices. They are used along with another code or password to enable a person to use an ATM or other electronic device. Keith Ferrell

Smartweed is an annual plant that grows as a weed in North America. Its flowers are pink or greenish, and it may grow 5 feet (1.5 meters) high. Smartweed grows in low places and fields, and along roadsides. It sometimes grows in water. The *lady's-thumb* is one of the most common smartweeds. Anton A. Reznicek

Scientific classification. Smartweeds belong to the buckwheat family, Polygonaceae. They are in the genus *Polygonum*. Lady's-thumb is *P. persicaria*.

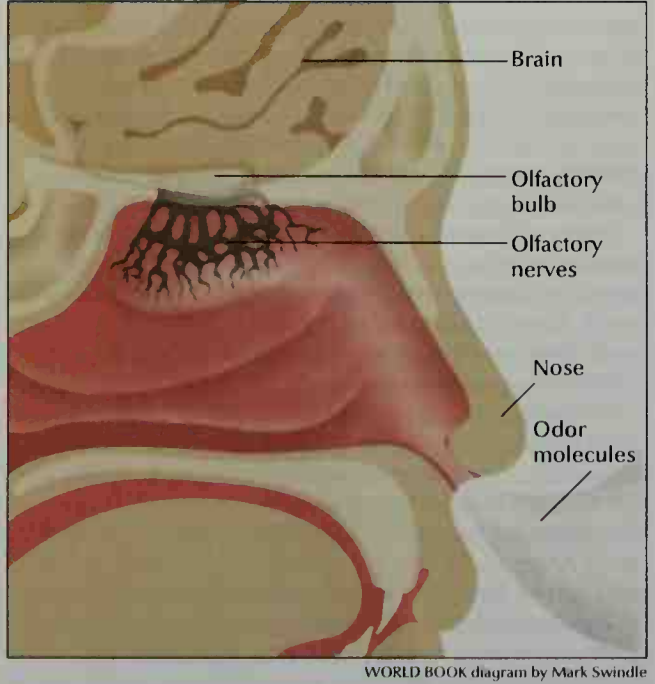
Smell is one of the most important and basic senses in animals and human beings. Some animals use the sense of smell to recognize their home territory, animals of their own kind, and other kinds of animals. They also use smell to find food and mates. The scientific term for smell is *olfaction,* and the system by which we smell is known as the *olfactory system.*

How odors are detected. People and land-dwelling *vertebrates* (animals with backbones) detect smells by breathing or sniffing air that carries odors. Odors come from molecules of gas that have been released into the air from many different substances. These molecules stimulate *receptor cells* deep inside the nose. The cells, which are part of the olfactory nerves, are on layers of mucus-covered tissue. This tissue covers nasal bones called *turbinates* or *conchae.* The receptor cells send the impulses created by the odor along the olfactory nerves.

The olfactory nerves then carry the impulses to a part of the brain called the *olfactory bulb.* In dogs and some other vertebrates, the olfactory bulb is large, but in people it is relatively small. The size of an animal's olfactory bulb may be an indication of how important the sense of smell is to that animal. From the olfactory bulb, the nerve impulses travel toward the *forebrain,* at the front of the cerebrum of the brain. Parts of the forebrain process the impulses into information about the odor.

Scientists do not know exactly how different smells are distinguished. One explanation is that molecules of certain odors become more quickly and more strongly attached to the mucus at a particular place on the turbinates than do other molecules. Therefore, molecules of certain kinds of odors will always stimulate the same receptor cells on the conchae. According to this theory, an odor is distinguished by how fast and where its molecules become attached to the receptor cells.

Another theory is that odor molecules stimulate any one or combination of receptor cells differently. Each receptor cell's genes may cause the production of special proteins that attach easily only to certain odor molecules. The attachment of a few odor molecules triggers nerve impulses from the receptor cell to the brain.



WORLD BOOK diagram by Mark Swindle

Structures important in smell are shown in this cutaway view of the head. Odor molecules travel through the nose and stimulate olfactory nerves. These nerves then send impulses to the olfactory bulb, which relays the message deeper into the brain.

Taste and smell. Generally, we taste and smell food at about the same time. Thus, we have come to think of the two senses as being related. But they are, in fact, separate. Only at some point in the brain are the separate senses combined.

The smell-stimulus parts in food can be separated from the taste-stimulus parts. This separation can be achieved by blowing clean air into the nose while the food is put into the mouth, or by allowing food to contact the taste buds but not the air. When smell stimuli are separated from taste stimuli, people cannot identify some foods and beverages—for example, cherries, chocolate, and coffee—though they still taste them.

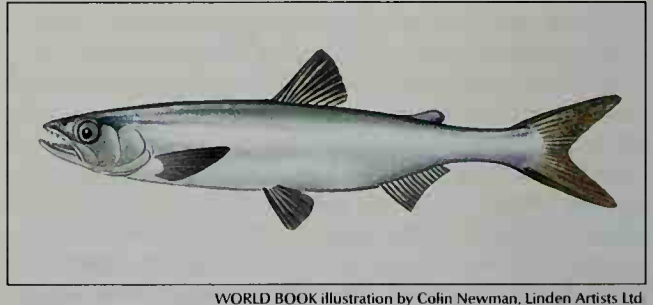
Bruce P. Halpern

See also **Dog** (Senses); **Insect** (Smell); **Nose; Senses; Taste.**

Smelling salts are used to relieve faintness and headaches. The salts are made up of ammonium carbonate mixed with perfume. This drug is known as a stimulant. The ammonia fumes from the salts irritate the membranes of the nose and lungs. This irritation results in a reflex that causes the muscles controlling breathing to work faster. Barbara M. Bayer

See also **Ammonia.**

Smelt is the name of a family of silvery fishes found in cool waters of the Northern Hemisphere. There are 10 species. Most measure less than 8 inches (20 centimeters) long. Like trout and salmon, smelts have a small, fleshy fin behind the dorsal fin on the back.



WORLD BOOK illustration by Colin Newman, Linden Artists Ltd

Smelts are food fish. The rainbow smelt, *shown,* lives along the Atlantic Coast and in cold-water lakes of North America.

Some species of smelts live only in salt water. They are found in the northern parts of the Atlantic and Pacific oceans and in the Arctic Ocean. Other species live only in freshwater rivers and streams that drain into these oceans. Still other species live chiefly in salt water but move to fresh water to *spawn* (lay eggs).

The *rainbow smelt* is the most common species of smelt. It is found along the Atlantic coast of Canada and the northern United States, along the Pacific coast of Alaska, and in coastal waters of the Arctic Ocean. It also has been introduced into the Great Lakes and smaller lakes in eastern North America. Many people fish for rainbow smelts with nets during the spring, when these fish spawn. At other times of the year, the fish are caught with hooks.

Smelts are valuable food fish, and many are sold frozen. Some people consider fresh smelt a delicacy.

David W. Greenfield

Scientific classification. Smelts belong to the smelt family, Osmeridae. The rainbow smelt is *Osmerus mordax.*

See also Capelin; Eulachon.

Smelting is a method by which metals are taken from their original ore. Smelting is done in specially built furnaces. The blast furnace for making pig iron is as tall as a 10-story building. Iron ore, coke, and limestone are fed through the top of the furnace. Hot *blast* (preheated air) enters at the bottom. This blast burns the coke and generates the gases and heat required to reduce iron from its oxide minerals in the ore and to form *slag* by the reaction of limestone and such unwanted ore components as silicon and phosphorus (see **Slag**). Molten slag and iron are removed through openings in the bottom. Furnace gas is removed at the top. Industry also uses blast furnaces to smelt other ores to produce copper, lead, and *ferroalloys* (alloys containing iron).

The *reverberatory* furnace is a type of smelter commonly used to refine copper. This smelter uses hot combustion gases to melt both the solid ore and certain substances called *flux materials* that are added to promote melting and to prevent oxide formation.

In *flash smelting* of copper ores, heat is generated by the reaction of oxygen with the sulfur in the ore minerals. The copper sinks to the bottom of the smelter in a liquid called *matte.* Matte, which contains iron sulfides and other sulfide compounds, is then refined to isolate copper.

James A. Clum

Related articles in *World Book* include:

Copper (Smelting)
Flux
Gold (diagram)
Industrial Revolution (Early ironmaking)
Iron and steel (How iron is made)
Lead (Production)
Metallurgy (Smelting)

Smetana, *SMEH tah nah,* **Bedřich,** *BEH dur zhihk* (1824-1884), was a Czech composer. He and Antonín Dvořák are considered founders of the Czech national school of music. Smetana's eight operas established the Czech national operatic tradition. The most popular of these operas is *The Bartered Bride* (1866), though the most patriotic is *Libuse* (1872). His cycle of six symphonic poems, *Ma Vlast (My Fatherland,* 1879), is also famous. It includes the familiar *River Moldau.* Smetana composed the autobiographical string quartet in E minor *From My Life* (1876), which influenced later quartets by the Czech composer Leoš Janáček.

Smetana was born on March 2, 1824, in Litomyśl, Bohemia, near Pardubice. He grew up speaking German but joined Czech patriots in an unsuccessful 1848 revolution against Prussian domination. From 1866 to 1874, he served as conductor of the National Theatre in Prague, where he introduced many new Czech, German, and French operas.

Vincent McDermott

Smilax, *SMY laks,* is the name of a group of woody or nonwoody vines that have hardy, sometimes thick, roots and strongly veined leaves. Smilaxes climb by means of slender threadlike structures called *tendrils,* which grow at the base of each leaf. The vines grow in temperate and tropical climates throughout the world and bear clusters of red, blue, or black berries. A well-known American species is the *common greenbrier.* The roots of some species of smilaxes yield *sarsaparilla,* a flavoring. The stems of other species may be worked into baskets. See also Greenbrier.

Theodore R. Dudley

Scientific classification. Smilaxes belong to the lily family, Liliaceae.

Smith, Adam (1723-1790), is generally regarded as the founder of modern economics. Smith's major book was *The Wealth of Nations* (full title: *An Inquiry into the Nature and Causes of the Wealth of Nations*). Published in 1776, it was the first complete work on political economy. The book discusses the relationship between freedom and order, analyzes economic processes, and attacks the British mercantile system's limits on free trade (see **Mercantilism**). All three aspects are woven together to create a unified social theory.

The book dealt with the basic problem of how social order and human progress can be possible in a society where individuals follow their own self-interests. Smith argued that this individualism led to order and progress. To make money, people produce things that other people are willing to buy. Buyers spend money for those things that they need or want most. When buyers and sellers meet in the market, a pattern of production develops that results in social harmony. Smith said that all this would happen without any conscious control or direction, "as if by an invisible hand."

Smith also believed that labor—not land or money—was both the source and the final measure of value. He said that wages depended on the basic needs of workers, and rent on the productivity of land. Profits, he said, were the difference between selling prices and the cost of labor and rent. Smith said profits would be used to expand production. This expansion would in turn create more jobs, and the national income would grow.

He believed that free trade and a self-regulating economy would result in social progress. He criticized the British government's tariffs and other limits on individual freedom in trade. He preached that government need only preserve law and order, enforce justice, defend the nation, and provide for a few social needs that could not be met through the market. His argument for a "hands off" government policy toward business, along with his analysis of economic forces, formed the basic ideas of *economic liberalism.* See **Liberalism; Capitalism.**

Smith was born on June 5, 1723, in Kirkcaldy, Scotland. He studied at the University of Glasgow and Oxford University. In 1751, he became a professor at Glasgow. He wrote *The Theory of Moral Sentiment* (1759) there. This philosophical work gained Smith an appointment in 1764 as tutor of the young Duke of Buccleuch. The tutoring took Smith to France, where he started writing *The Wealth of Nations.* When Smith returned to England in 1766, the duke's stepfather provided Smith with a regular income. The money enabled Smith to retire from teaching and devote the next 10 years of his life to writing. He died on July 17, 1790.

The Wealth of Nations went through five editions during Smith's lifetime. But it had little major influence on economic policy until the early 1800's.

Daniel R. Fusfeld

Additional resources

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Griswold, Charles L., Jr. *Adam Smith and the Virtues of Enlightenment.* Cambridge, 1999.

Smith, Alfred Emanuel (1873-1944), was an American political leader. He was elected governor of New York four times. In 1928, he was an unsuccessful candidate for president of the United States.

Smith, known by the nickname Al, became active in politics at the age of 22. He worked his way up in the Tammany Hall machine to become a leader of the Democratic Party. He was elected to the state legislature in 1903 and became governor of New York in 1919.

Smith failed to win the Democratic Party's nomination for president in 1924. But in 1928, he won the nomination with the help of his friend and associate, Franklin D. Roosevelt. The *Happy Warrior,* as Roosevelt called him, lost the election to Herbert Hoover. Some opposed Smith because he was a Roman Catholic and because he opposed prohibition. At the start of the depression of the 1930's, Smith supported federal spending. Later, Smith broke with Roosevelt, who was elected U.S. president in 1932. Smith became critical of Roosevelt's New Deal policies and joined the Liberty League, an anti-Roosevelt group (see New Deal; Liberty League). Smith was born in New York City. James S. Olson

Smith, Bessie (1894-1937), became one of the finest blues singers in the history of jazz. A series of recordings she made from 1923 to 1933 rank among the best in jazz. Smith applied the strength and beauty of her voice to simple songs. Louis Armstrong, Fletcher Henderson, Joe Smith, and James P. Johnson were among the jazz musicians who played on her records.

Bessie Smith was born in Chattanooga, Tennessee, into extreme poverty. She left home when she was a teen-ager to tour with a minstrel show. A recording director discovered her and brought her to New York City. The black public bought millions of her records during the years of her greatest fame from 1923 to 1928. Her work was almost unknown to white audiences until shortly before her death. Smith died of injuries suffered in an automobile accident in Mississippi. Frank Tirro

Smith, David (1906-1965), was an American sculptor who worked with metals in many forms. His most typical works are muscular metaphors resembling hieroglyphics in wrought iron. His work has influenced sculptors who create their work out of junk materials. Smith's *Cubi XIX* appears in the Sculpture article.

Smith was born in Decatur, Indiana. While working on a Studebaker automobile plant assembly line, he learned the metal techniques he used in his later work. In 1926, Smith went to New York City to study at the Art Students League. He began to create welded iron works after seeing Pablo Picasso's welded sculpture and the forged iron constructions of Julio González of Spain in the early 1930's. George Gurney

Smith, Dean (1931-), won more games than any other coach in college basketball history. In March 1997, Smith won his 877th game as a head coach, breaking the record held by Adolph Rupp of the University of Kentucky. Smith spent his entire head coaching career at the University of North Carolina. His teams won National Collegiate Athletic Association (NCAA) championships in the 1981-1982 and 1992-1993 seasons. Smith coached many all-American players, including Phil Ford, Michael Jordan, Sam Perkins, and James Worthy.

Dean Edwards Smith was born in Emporia, Kansas. He graduated from the University of Kansas in 1953 and began his career there as an assistant coach. He was an assistant coach at the Air Force Academy for three years and then served as an assistant coach at North Carolina from 1958 to 1961, when he became head coach. Smith retired in 1997 with a career record of 879 victories and 254 losses. Dave Nightingale

Smith, Donald Alexander. See Strathcona and Mount Royal, Baron of.

Smith, Edmund Kirby (1824-1893), was a Confederate general in the American Civil War. He led troops in the first Battle of Bull Run (Manassas) as a brigadier general in 1861 and in the Kentucky campaign as a major general in 1862. In 1863, he took command of the Confederate Trans-Mississippi Department. He became a full general in 1864. Smith was the last Southern general to surrender a major force after the war ended in 1865.

Smith, born in St. Augustine, Florida, received his mother's maiden name, Kirby, as his middle name. The family name later became Kirby-Smith. He graduated from the U.S. Military Academy and fought in the Mexican War (1846-1848). A statue of Smith represents Florida in the U.S. Capitol. Steven E. Woodworth

Smith, Emmitt (1969-), ranks among the leading running backs in professional football. Smith plays for the Dallas Cowboys of the National Football League (NFL). He led the NFL in rushing four seasons and in touchdowns three seasons. Smith was awarded the Jim Thorpe Trophy as the NFL's Most Valuable Player in 1993. He was a star on Dallas teams that won the Super Bowl in 1993, 1994, and 1996.

Smith stands 5 feet 9 inches (175 centimeters) tall and weighs about 210 pounds (95 kilograms). Although small for an NFL running back, he has been exceptionally durable, leading the NFL in rushing attempts three times. Smith has the power to gain difficult short yardage and the speed to break away for long gains.

Emmitt James Smith III was born in Pensacola, Florida. He attended the University of Florida, setting season and career rushing records there. He left college in 1990 after his junior year, and Dallas chose him as the 17th player in the NFL draft later that year. Bob Carroll

Smith, James (1719?-1806), was a Pennsylvania signer of the Declaration of Independence. He urged a boycott of British goods and a general congress of colonies when he was a delegate to a conference in Philadelphia in 1774. He helped draft a resolution for independence at the provincial conference in June 1776. He served in the Continental Congress from 1776 to 1778 and as judge of the Pennsylvania High Court of Errors and Appeals in 1781. He was born in Ireland. Gary D. Hermalyn

Smith, Jedediah Strong (1799-1831), was an American trader and explorer. He traveled widely and provided many other pioneers with valuable information about the American West.

Smith was born in Bainbridge, New York. As a young man, he went to Missouri and entered the fur trade. He set out in 1826 to find trade routes to California and the Northwest. From the Great Salt Lake, he crossed Ute and Paiute Indian territories, the Mojave Desert, and the High Sierras, until he reached southern California. He then started north to find a pass across the Sierra Nevada. While returning to California the next year, Indians killed 10 members of his party. In 1828, he led an expedition to Fort Vancouver (now Vancouver, Washington),

but an Indian attack along the way wiped out most of his party. In 1831, Smith himself was killed by Indians on the Santa Fe Trail. William E. Foley

Smith, John (1580?-1631), was an English soldier and adventurer. He helped establish the first permanent English colony in America, at Jamestown, Virginia.

According to a book that Smith wrote, he was once captured by unfriendly Indians while on an expedition in the wilderness. The Indian chief, Powhatan, intended to kill Smith, but Pocahontas, the chief's daughter, stopped the execution. Smith was released, and he returned to Jamestown. Pocahontas remained Smith's friend and warned him of at least one Indian plan to attack the settlement. See **Pocahontas; Powhatan**.

Early years. John Smith was born in Willoughby, England, near Louth. He went to school until about age 15. Smith sought adventure, and so he left home and became a soldier. He fought in the Netherlands with the Dutch army against the Spaniards. In 1601, he joined the fight of several east European nations against invasion by the Ottoman Empire, which was based in what is now Turkey. Smith was quickly promoted to captain. Shortly after his promotion, the Ottomans captured Smith and sold him as a slave. He later escaped to Russia and then returned to England.

Life in the colonies. In 1606, Smith joined a group that sailed from England to establish a colony in Virginia. The expedition was financed by the Virginia Company of London, an organization formed partly by London business people (see **London Company**). These people believed gold and silver could be found in America, and the colonists were instructed to transport the precious metals back to England.

The colonists landed in Virginia in 1607 and founded a settlement, which they named Jamestown in honor of King James I. From the beginning, Jamestown suffered heavily from disease, starvation, and Indian attacks. Most of the colonists were unable or unwilling to work to feed and protect themselves. Smith served as president of the colony in 1608 and 1609. He enforced order, required all the colonists to work, and traded with the Indians for food.

Under Smith's leadership, Jamestown was almost free of hunger and disease. Smith treated the Indians harshly. They feared him, and so fewer conflicts occurred between the Indians and the colonists. But Smith's rough manner toward the Indians increased their hatred of the settlers. After Smith left Jamestown, the Indians increased their attacks against the colony.

Some of the settlers criticized Smith's leadership. Many of his opponents were aristocrats who resented being governed by a farmer's son. Smith sailed back to England in 1609 after being wounded in a gunpowder accident. That winter, the colony was almost wiped out by starvation and Indian raids.

Smith returned to America in 1614 and spent several months exploring the coast in the Massachusetts Bay area. He later named this region "New England."

In his later years, Smith lived in London and wrote several books that promoted American colonization. His most influential book was *The Generall Historie of Virginia, New England and the Summer Isles* (1624). Smith stressed the value of such products as fish, furs, and timber. He criticized the useless searches for gold and silver by earlier colonists. Smith also urged that future expeditions be carefully planned and that people chosen as colonists be willing to work and undergo hardship. Alden T. Vaughan

See also **American literature** (Virginia); **Jamestown**; **Map** (Mapping the Americas).

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Vaughan, Alden T. *American Genesis: Captain John Smith and the Founding of Virginia.* 1975. Reprint. HarperCollins, 1990.

Smith, Joseph (1805-1844), was the founder and first president of the Mormon Church, officially called the Church of Jesus Christ of Latter-day Saints. Several other churches recognize him as their founder. The largest of these is the Community of Christ (formerly called the Reorganized Church of Jesus Christ of Latter Day Saints). Those who follow Smith's teachings regard Smith as a prophet of God.

Early life. Smith was born in Sharon, Vermont, on Dec. 23, 1805, the fourth of 10 children. The Smiths faced hard times in Vermont. When Joseph was 11, his parents, Joseph and Lucy Mack Smith, moved the family to Manchester, New York, near Palmyra.

Oil portrait (1959) by Alvin Gittens; Church Administration Building, Board Room (Church Archives, Church of Jesus Christ of Latter-day Saints)

Joseph Smith

Young Joseph Smith was troubled by the counterclaims made by religious groups of his day. He could not decide which to join. In 1820, he went alone into the woods to seek God's guidance. According to his account, God the Father and His Son (Jesus Christ) appeared to him. They told him not to join any existing church and to prepare for important tasks.

Smith said the angel Moroni visited him in 1823, and told him he would receive gold plates on which he would find a book engraved in a strange language. Smith said he received the plates in 1827. His translation of the writings, called the *Book of Mormon,* was published in 1830. The book is a history of early peoples of the Western Hemisphere. Mormons and other followers of Joseph Smith believe the book was divinely inspired. They regard it as holy scripture.

Organizing the church. On April 6, 1830, Smith and five associates founded the Church of Jesus Christ of Latter-day Saints at Fayette, New York, with Joseph Smith as its leader. Smith moved to Kirtland, Ohio, in 1831, and made many converts there. The Mormons also established communities in Mentor, Ohio, and Independence, Missouri.

Smith instituted many of the church's present doctrines and its basic organization at Kirtland. He organized the *quorums* (groups) of the priesthood, which gave most male church members priestly authority. Later, in Missouri in 1838, he introduced *tithing* (giving one-tenth of one's income to the church).

In Kirtland, the church faced many problems. A bank

established by the Mormons failed in 1837, a year of national economic depression. The bank failure, opposition from persons who had left the church, and conflict with non-Mormons led to the breakup of the Kirtland community. Smith joined the Mormons in Missouri in 1838. There, hostilities arose between Mormons and non-Mormons. Non-Mormons feared the increasing size of the Mormon community and opposed their antislavery beliefs. The hostilities led to an armed conflict. Smith led the Mormons in their effort to defend themselves. The outnumbered Mormons surrendered, and Smith was imprisoned on what the Mormons regard as false charges. He escaped a few months later and joined his people who had fled from Missouri to Illinois.

Life at Nauvoo. Joseph Smith and the Mormons founded the city of Nauvoo (*the beautiful place*) in Illinois. Nauvoo's population reached about 12,000 in the middle 1840's, making it the largest city in the state. By that time, Smith headed a church with thousands of members. He was mayor of Nauvoo and a successful businessman. He headed the *Nauvoo Legion,* a small army authorized by the state to protect the community. The rapid growth of the Mormon church had political significance. In 1844, the year he was killed, he declared himself a candidate for president of the United States to rally public opinion for Mormon defense.

Smith instituted the doctrine of *polygamy* at Nauvoo in 1843. Polygamy is the practice of a man having more than one wife at the same time. Most non-Mormons and many Mormons disagreed with this practice. The church finally outlawed polygamy in 1890. Some members who did not agree with the doctrine of polygamy broke away in 1844. They set up a newspaper that criticized Smith. The paper was destroyed, and Smith was blamed for it. This caused a wave of hostility against him in Illinois. He and his brother Hyrum were jailed at Carthage, Illinois, on charges of rioting and treason, which the Mormons felt were false. A mob attacked the jail and killed the brothers on June 27, 1844. But the church continued to grow after Joseph Smith's death. Brigham Young led the main body of Mormons to present-day Utah, where they prospered.

Smith wrote the *Pearl of Great Price* (1830, 1835) and *Doctrine and Covenants* (1835) based on his revelations. He wrote an autobiography in 1842.

Critically reviewed by the Church of Jesus Christ of Latter-day Saints

See also **Community of Christ; Mormons; Utah** (History); **Illinois** (Places to visit [Nauvoo]).

Additional resources

Bushman, Richard L. *Joseph Smith and the Beginnings of Mormonism.* 1984. Reprint. Univ. of Ill. Pr., 1988.

Marquardt, H. Michael, and Walters, W. P. *Inventing Mormonism: Tradition and the Historical Record.* Signature Bks., 1994.

Smith, Margaret Chase (1897-1995), was the first woman to be elected to both houses of the United States Congress. Her husband was a Republican congressman from Maine. When he died in 1940, Mrs. Smith replaced him in the U.S. House of Representatives. She served four full two-year terms. She was elected to the U.S. Senate in 1948 and was reelected three times. She served in the Senate from 1949 to 1973. In 1950, she became one of the first senators to oppose tactics used by Wisconsin Senator Joseph R. McCarthy. In 1964, Smith campaigned for the Republican presidential nomination, the first woman ever to do so for a major party. She was born Margaret Madeline Chase on Dec. 14, 1897, in Skowhegan, Maine. Stephen E. Ambrose

Smith Act, or Alien Registration Act of 1940, makes it a crime to advocate the violent overthrow of the United States government or to belong knowingly to a group advocating it. In 1951, the Supreme Court upheld the act in the case of 11 convicted leaders of the Communist Party. But in 1957, the court ruled that teaching Communism or other revolutionary theories was not, in itself, grounds for conviction. Proof was required that the defendant had urged direct action to overthrow the government.

In 1961, the Supreme Court again upheld the conviction of a member of the Communist Party under the act. The court maintained that in this case the person had been an active member of the Communist Party and had intended to overthrow the government of the United States. Douglas L. Wheeler

Smith College, in Northampton, Massachusetts, is the largest private liberal arts college for women in the United States. Smith College's undergraduate school admits only women to its degree program, but its graduate school is coeducational. Undergraduates choose from about 1,000 courses in over 50 areas of study. Qualified students may study abroad and participate in internships or independent research projects. Smith College offers graduate degrees in many fields, including the arts, education, social work, and education of the deaf.

Smith College was founded in 1871. It is part of a consortium of western Massachusetts colleges, which allows students to take classes at other colleges.

Critically reviewed by Smith College

Smithson, James (1765-1829), a British scientist, founded the Smithsonian Institution. In his will, he gave more than $500,000 to the United States to establish an institution for the "increase and diffusion of knowledge among men." After much debate over whether the United States could legally accept the gift, Congress agreed. In 1846, Congress established the Smithsonian Institution at Washington, D.C.

Smithson was born in Paris in 1765, but the exact date of his birth is unknown. He was educated at Oxford University. Smithson became known for his researches in chemistry and mineralogy. One of the many minerals that he studied was named *smithsonite* (zinc carbonate) in his honor. He died in Genoa, Italy, on June 27, 1829.

Richard G. Olson

See also **Smithsonian Institution.**

Smithsonian American Art Museum is a bureau of the Smithsonian Institution in Washington, D.C. The collection of about 38,000 works includes paintings, sculptures, folk art, prints, drawings, photographs, and craft objects by American artists. It covers American art from the mid-1700's to the present. The museum also presents special exhibitions, provides facilities for research, and offers educational programs.

The museum exhibits the works of painters Albert Pinkham Ryder and George Catlin as well as such American Impressionists as Childe Hassam and Thomas Wilmer Dewing. Other featured artists include Edward Hopper, Stuart Davis, Romaine Brooks, Robert Rauschenberg, William H. Johnson, Helen Frankenthaler, and

Luis Jiménez. The Smithsonian American Art Museum is in Washington, D.C.

Critically reviewed by the Smithsonian American Art Museum

Smithsonian Institution is a federally chartered nonprofit organization of scientific, educational, and cultural interests headquartered in Washington, D.C. James Smithson, a British scientist, left his fortune to the United States in 1829 to found an establishment for the "increase and diffusion of knowledge among men." The United States Congress established the Smithsonian in 1846.

Administration. A board of regents governs the institution. It consists of the chief justice and the vice president of the United States, three members each of the U.S. Senate and the House of Representatives, and nine private citizens appointed by joint resolution of Congress. The secretary of the institution acts as executive officer and directs its activities.

Museums. The Smithsonian operates numerous museums. Many of these museums display artworks. Others feature exhibits on American history, natural history, aeronautics and space exploration, or science and technology.

The Smithsonian American Art Museum surveys American art from colonial times to today. The museum's Renwick Gallery features American crafts of the 1900's. The National Portrait Gallery exhibits likenesses of people who have contributed significantly to U.S. history, development, and culture. The Freer Gallery of Art displays masterpieces of Near and Far Eastern art, early Christian manuscripts, and a collection of works by the American painter James McNeill Whistler. The Arthur M. Sackler Gallery houses Asian and Near Eastern art.

The Hirshhorn Museum and Sculpture Garden emphasizes modern painting and sculpture. The National Museum of African Art exhibits arts of Africa south of the Sahara. The Cooper-Hewitt, National Museum of Design in New York City maintains a collection of over 85,000 items of decorative art. The Anacostia Museum is devoted to African American history and culture.

The National Museum of Natural History has exhibits and conducts research on biology, human cultures, mineral sciences, and *taxonomy* (the scientific classification of plants and animals). The National Museum of American History houses collections representing American cultural, civil, and military history, as well as scientific and technological advances. The National Air and Space Museum records U.S. air and space flight developments. The National Postal Museum displays the Smithsonian's postage stamp collection.

Other facilities operated by the Smithsonian include a zoo and centers for scientific research and cultural exchange. The zoo, called the National Zoological Park, has more than 2,000 mammals, birds, and reptiles.

The Smithsonian Astrophysical Observatory, in cooperation with the Harvard College Observatory, operates a research center in Cambridge, Massachusetts. The center, called the Harvard-Smithsonian Center for Astrophysics, conducts studies on the physical and chemical processes that occur in the universe. It runs an observatory near Tucson, Arizona. The Smithsonian Tropical Research Institute in Panama studies tropical biology, especially the behavior patterns and ecological adaptations among marine and land wildlife.

Affiliated institutions. Three institutions affiliated with the Smithsonian have their own governing boards. They are the National Gallery of Art, the Woodrow Wilson International Center for Scholars, and the John F. Kennedy Center for the Performing Arts.

The National Gallery of Art maintains a collection of paintings, sculpture, and the graphic arts representative of the best in the artistic heritage of the United States and Europe. The Woodrow Wilson International Center for Scholars was established by Congress to be the nation's official memorial to the 28th president. The center's fellowship program is devoted to contemporary issues and to fostering closer ties between scholars and government leaders. The John F. Kennedy Center for the Performing Arts is a national cultural center and memorial to President John F. Kennedy. The Kennedy Center presents concerts, operas, plays, dance, lectures, and many other programs.

Critically reviewed by the Smithsonian Institution

Related articles in *World Book* include:

Freer Gallery of Art
Henry, Joseph
Hirshhorn Museum and Sculpture Garden
Kennedy Center for the Performing Arts
National Air and Space Museum
National Museum of African Art
National Museum of American History
National Museum of Natural History
National Zoological Park
Smithson, James
Smithsonian American Art Museum
Washington, D.C.

Smog is a form of air pollution. The term was first used in 1905 to describe the combination of *sm*oke and thick f*og* that at times hung over London and other cities in the United Kingdom. Today, smog also refers to a condition caused by the action of sunlight on the exhaust gases from automobiles and factories. This type of smog is sometimes called *photochemical smog*.

Weather conditions such as a lack of wind or a *thermal inversion* may cause smog to build up in an area. A thermal inversion occurs when a layer of warm air settles over a layer of cool air that lies near the ground. This condition prevents the smog from rising and scattering. Mountain ranges near cities may also trap smog in an area.

Heavy concentrations of smog are poisonous. In 1948, 20 people died and nearly 6,000 became ill from a photochemical smog over Donora, Pennsylvania. About 4,000 Londoners died within five days as a result of a thick smog in 1952. Smog also destroys plant life. In addition, smog causes building materials to deteriorate faster than usual.

London-type smog occurs when moisture in air condenses on smoke particles produced by the burning of coal, forming tiny smog droplets. A dangerous part of London-type smog is sulfur dioxide, a gas that attacks the lungs and makes breathing difficult. For this reason, London-type smog is sometimes called *sulfur smog*.

Photochemical smog involves the action of sunlight on *hydrocarbons* and *nitrogen oxides* in the air. These compounds are chemicals formed by the burning of gasoline and other petroleum products. When activated by sufficient sunlight, the compounds undergo a chemical reaction that produces gases called *oxidants*. Ozone forms the most abundant oxidant in photochemical smog. It can irritate the eyes, nose, and throat and dam-

age the lungs. Other oxidants in smog include nitrogen dioxide and peroxyacetyl nitrate (PAN). David J. Kolaz

See also Air pollution (picture); Ozone.

Smoke consists of finely divided solid and liquid particles *suspended* (held) in a gas. Smoke is mostly made up of carbon particles produced by the burning of fuel. Smoke particles are tiny and penetrate easily into the lungs to cause serious damage. Smoke also blackens buildings, corrodes metals, and damages vegetation, causing serious economic losses. Smoke has a few helpful uses. These include preserving meats, producing colored military signals, and protecting orchards with smudge pots during freezes. Smoke may become dangerously concentrated during a weather condition called *thermal inversion.* This condition occurs when a layer of warm air settles over a layer of cooler air that lies near the ground. The warm air traps the cool air and prevents the smoke from rising and scattering. See also Air pollution; Environmental pollution. David J. Kolaz

Smoke alarm is a device used in homes and other locations, such as aircraft and commercial buildings, to warn people of smoke or a fire. The alarm makes a loud noise within seconds after smoke enters its vents.

Two detection methods are used in smoke alarms: *ionization detection* and *photoelectric detection.* An alarm may use one or both types. Ionization detection uses a tiny radioactive cell to electrically charge molecules of air, creating particles called *ions.* The ions produce an electric current that flows continuously. Smoke particles become attached to the ions and reduce the flow of the current, setting off the alarm. Photoelectric detection uses a light source that shines into a chamber, plus a light-sensitive device called a *photocell.* Smoke scatters the light from the source and reflects it onto the photocell. The photocell then triggers the alarm.

Smoke alarms operate on household current, battery power, or both. Building codes specify power, location, and installation requirements. Typical locations include in and just outside sleeping areas, and on each level of a home. Smoke alarms must be installed on a ceiling, at least 4 inches (10 centimeters) from the wall, or on a wall, with the top of the device between 4 and 12 inches (10 and 30 centimeters) from the ceiling.

Critically reviewed by the National Fire Protection Association

Smoking is drawing tobacco smoke from a cigarette, cigar, or pipe into the mouth—and often into the lungs—and puffing it out. The term usually refers to cigarette smoking, the most common form of smoking.

People have smoked tobacco for thousands of years. American Indians smoked tobacco in pipes during religious ceremonies long before Europeans came to the New World. In the United States, cigarette smoking became popular during the 1900's. Advances in the manufacture of cigarettes made smoking more affordable, and tobacco companies spent millions of dollars on advertising. Cigarette consumption in the U.S. rose from an average of 54 cigarettes per person per year in 1900 to 4,148 cigarettes per person per year in 1973. But by the late 1990s, cigarette consumption had declined to an average of 2,000 cigarettes per person per year. Today, less than a fourth of adults in the United States smoke cigarettes.

Nearly all smokers smoke to satisfy a craving for *nicotine,* a chemical substance that occurs naturally in tobacco and tobacco smoke. Nicotine is a poisonous and highly addictive substance. A typical cigarette contains about 1 milligram ($\frac{1}{30,000}$ ounce) of nicotine. The chemical affects the nervous system as both a stimulant and a depressant, so smoking can feel both refreshing and relaxing at the same time.

Nicotine interferes with chemicals called *neurotransmitters,* which carry messages from one nerve cell in the brain to another. Over time, the balance of neurotransmitters in the brain changes as the brain adapts to the nicotine from cigarette smoke. When smokers stop smoking, an imbalance occurs in the brain, giving smokers a feeling of anxiety. The relaxation that smokers usually experience when smoking actually comes from relief of their nicotine craving.

Since the mid-1900's, scientists have accumulated evidence that smoking is dangerous to a person's health. In 1964, the United States surgeon general first officially warned that smoking caused lung cancer. Since then, scientists have shown that cigarette smoking causes heart disease, lung disease, and many other health problems. In 1988, the surgeon general concluded that nicotine was an addictive drug. Cigar and pipe smoking and chewing tobacco also lead to nicotine addiction and can cause cancers of the mouth and throat.

Why smoking is dangerous. Tobacco smoke contains more than 4,000 chemicals, including many *carcinogens* (substances known to cause cancer). Other chemicals in tobacco smoke coat or dissolve the lining of the lungs and interfere with the normal functioning of blood and blood vessels.

Cigarette smoke contains carbon monoxide, a colorless, odorless gas that reduces the oxygen-carrying ability of red blood cells. Other chemicals found in cigarette smoke include hydrogen cyanide, nitrogen oxides, benzene, and ammonia. The smoke also contains tiny solid particles called *tar.* These particles contain chemical compounds called *polycyclic aromatic hydrocarbons,* which are carcinogens that also damage blood vessels. Cigarette smoke also contains harmful metals such as nickel, zinc, and radioactive polonium-210.

When smokers inhale, hot gases burn the lining of the airways, and the larger tar particles are deposited in the airways leading to the lungs. Over time, the smoke scars the lungs and damages the *cilia,* thousands of tiny hairs that line airways and keep them clean. The damage increases a smoker's chances of developing bronchitis, influenza, and other lung infections. The smoke also harms tiny air sacs in the lungs, which can lead to *emphysema,* a serious lung disease.

The chemicals in cigarette smoke are absorbed into the blood through the lungs and distributed throughout the body. The chemicals can accumulate in organs, leading to cancer in the kidney, pancreas, bladder, and cervix. Among pregnant smokers, the chemicals reach the developing baby, retarding growth and increasing the chance of *spontaneous abortion* (miscarriage).

Smoking damages the heart and blood vessels. Cigarette smoke increases the activity of *blood platelets,* which cause blood to clot. It also reduces the ability of blood vessels to *dilate* (expand) and contract to adjust blood flow. These changes contribute to artery blockages, which can cause heart attack or stroke.

Secondhand smoke. Researchers have found that

smoke from a smoldering cigarette, cigar, or pipe, called *secondhand smoke,* can cause lung cancer and other diseases in nonsmokers exposed to it. Because the smoke does not pass through a cigarette filter, it often contains more toxic chemicals than exhaled smoke.

Secondhand smoke can also cause irritation in the throat and eyes, nausea, and headaches in nonsmokers. Breathing secondhand smoke also damages blood and blood vessels in ways similar to that found in people who smoke. Secondhand smoke around infants increases the risk of Sudden Infant Death Syndrome (SIDS), asthma, and respiratory infections.

How smokers quit. Breaking nicotine addiction and quitting smoking is difficult. Most people who try to stop return to smoking within a year, and people usually have to try many times before they finally quit.

Most smokers who stop smoking quit on their own, but some benefit from clinics that specialize in helping smokers quit. People sometimes use special chewing gum or skin patches that slowly release nicotine into the bloodstream. These products help many people reduce the nicotine craving that develops as they stop smoking. Living in a smoke-free home or working in a smoke-free workplace usually aids a smoker's effort to quit.

Smokers who quit experience immediate health benefits. Within a day, blood pressure, heart rate, and the oxygen-carrying capacity of red blood cells return to normal. The risk of heart attack also decreases. Within a week, lung function improves, and the effects of smoking on pregnancy are reduced. Within a year, the cilia return to normal in the lungs, and the risk of heart attack is reduced to about double that of a nonsmoker. About 10 years after a smoker quits, the risk of developing lung cancer is nearly the same as that for a nonsmoker.

Smoking regulations. Legislation and policies regulating smoking have provided increased protection for nonsmokers and have influenced many smokers to smoke less or quit. A 1964 United States law requires that all packaging and advertising for cigarettes carry a health warning. Federal laws in Canada place age limits on tobacco sales, require health warnings on cigarette packages, and restrict advertising. Hundreds of communities in the United States and other countries have also passed laws that prohibit smoking in workplaces, public places, restaurants, and taverns.

In the early 1990's, smokers in the United States filed several class action suits, which enable people to sue as a group rather than as individuals. These suits claimed tobacco companies had hidden evidence that nicotine was addictive and manipulated nicotine levels to keep smokers dependent. About the same time, secret tobacco industry documents were leaked to the public. The documents showed that the tobacco industry knew that smoking caused disease and nicotine was addictive, but kept the information secret.

The newly discovered evidence strengthened a series of lawsuits that several states had brought against the tobacco industry. The lawsuits sought to force the tobacco industry to reimburse the states for the costs to taxpayers for treating smoking-related illness. In 1996, one tobacco company, the Liggett Group, agreed to settle some of the suits. By 1998, tobacco companies and all states that had not previously settled their claims reached a broad settlement. The tobacco industry agreed to pay states according to a formula tied to the smoking population in each state. The payments amount to almost 250 billion dollars to be paid over 25 years. Many states are using some of the settlement money to fund anti-smoking programs.

In 2001, juries awarded financial compensation to individual smokers who sued tobacco companies in Florida, California, and Oregon. The lawsuits claimed that the smokers, or their families, should receive compensation because the tobacco industry had lied about the dangers of smoking and the addictiveness of nicotine.

Stanton A. Glantz

See also Emphysema; Lung cancer; Tobacco.

Additional resources

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Hirschfelder, Arlene B. *Encyclopedia of Smoking and Tobacco.* Oryx, 1999.

Kranz, Rachel. *Straight Talk About Smoking.* Facts on File, 1999.

Pietrusza, David. *Smoking.* Lucent Bks., 1997. Younger readers.

Smoky Mountains, Great. See Great Smoky Mountains.

Smollett, *SMAHL iht,* **Tobias George** (1721-1771), was one of the great early English novelists. His novels are loosely constructed accounts of amusing and sometimes vulgar incidents in the hero's life. They are read for their eccentric characters, bitter social satire, and broadly comic high spirits. Smollett was born near Dumbarton, Scotland, and became a doctor. After an adventurous life as a ship's doctor, he settled in London. His first two novels, *The Adventures of Roderick Random* (1748) and *The Adventures of Peregrine Pickle* (1751), draw heavily on his sea experiences. *The Expedition of Humphry Clinker* (1771) is generally considered his best novel. Told in letters, it portrays a bizarre family traveling through England and Scotland. Gary A. Stringer

Smooth fox terrier is a small, alert dog originally bred for use in fox hunts. The dog stands about 15 inches (38 centimeters) tall and weighs about 18 pounds (8 kilograms). The dog is white in color with patches of black or tan, or both black and tan. Its coat is smoother than that of the wire fox terrier (see Wire fox terrier). A smooth fox terrier has legs well suited for running. The quick action of its upright tail gives the dog a lively look. The breed was developed in southern England in the mid-1800's. The dog has good eyesight and a keen sense of smell. It is also fast and strong for its size. It makes an excellent companion. See also Dog (picture: Smooth fox terrier). Critically reviewed by the American Fox Terrier Club

Smuggling is the illegal transportation of people or goods into or out of a country or area. Most people who smuggle goods are trying to avoid the payment of *customs duties,* or taxes (see Tariff). But drug smugglers want big profits for illegal drugs—that is, drugs whose possession and sale are normally forbidden by law. Most countries put customs officers at seaports and along their borders. These officers may examine shipments of merchandise as well as the baggage of travelers to make sure customs duties are paid. Some countries ban the importation of a particular article. For example, the United States once prohibited the importing of alcoholic liquors. Violation of such laws also is called smuggling. Illegal drugs involved in smuggling include marijuana, cocaine, and heroin.

People guilty of smuggling may be punished by fines, imprisonment, or by having the goods taken, according to the seriousness of the offense. In the United States, no one is held guilty of smuggling unless he or she has acted intentionally. Edwin B. Firmage

Smut is the name of certain plant diseases. Smut affects both cultivated and wild plants but is particularly harmful to cereal grains, such as barley, corn, oats, rice, and wheat. Smut diseases are caused by fungi that live as parasites on plants. The parasite causes damage by producing masses of black spores on the plants. In many smut diseases of cereal crops, the parasite destroys the seeds or even the plant's grain-producing flowers.

Smut diseases in oat, wheat, and barley plants commonly damage both the seeds and the flowers. The smut diseases that most often affect wheat are *stinking smut,* also called *bunt,* and *loose smut. Covered smut* affects barley and oats. When the infected plants are harvested and threshed to remove the seeds, smut spores are released into the air and can attach to healthy seeds. After these seeds are planted, the spores *germinate* (start to grow) and infect the seedlings. The spores develop into mature fungi in the young plant's stem, often without causing external symptoms. But after the plant matures, the fungi may destroy the plant's flowering parts. See Wheat (Care during growth).

Another common smut disease is *corn smut.* It chiefly affects the ears of the corn plant but can cause lumps of spores on any aboveground part of the plant. When the spores ripen, they are released into the air in large numbers. These spores can survive in the soil through the winter and cause disease in the next year's crop. Corn smut is edible and is considered a delicacy by some people. See Fungi (picture: Corn smut).

Smut-causing fungi on plant seeds can be killed with chemical treatments. Most diseases can be controlled if the seeds are treated before being planted. Some types of cereal plants are resistant to smut diseases. Many farmers cultivate these varieties rather than risk an outbreak of smut. Joseph G. Hancock

Smuts, *smuhts,* **Jan Christiaan,** *yahn KRIHS tee ahn* (1870-1950), was one of South Africa's greatest statesmen and military leaders. He helped create the Union of South Africa in 1910 and served as prime minister from 1919 to 1924 and from 1939 to 1948. An Afrikaner of mainly Dutch ancestry, he fought against British forces in the second Anglo-Boer War (1899-1902). But he later wanted South Africa to maintain close ties with the United Kingdom. Smuts played an important role in transforming the British Empire into the Commonwealth of Nations during the 1920's and 1930's. He also was a key international figure because of his military leadership in World War I (1914-1918) and World War II (1939-1945) and his role in peace efforts after those wars.

British South Africans and moderate Afrikaners were loyal to Smuts during his career. But many Afrikaners distrusted Smuts because of his pro-British views.

Smuts was born on May 24, 1870, near Riebeek-West in what is now Western Cape province. He studied law at Cambridge University in England. Smuts became a skillful military leader for the Boers (Afrikaners) during the Anglo-Boer War. But after the British defeated the Boers, he helped prepare the peace settlement.

Smuts worked to unify South Africa's Afrikaner and British populations. In 1910, he helped merge four British colonies, including two former Boer republics, into the Union of South Africa. Smuts played a major role in drafting the Union's constitution, and he served in various cabinet roles. In 1914, after South Africa entered World War I on the British side, Smuts crushed an Afrikaner rebellion. During the war, Smuts led successful invasions of German-held territories in Africa. In 1917, he became a member of the British War Cabinet in London. In 1919, he helped found the League of Nations.

Smuts became prime minister of South Africa in 1919 but was defeated in the 1924 election. In 1933, Smuts became deputy prime minister. In 1939, despite objections from Afrikaner nationalists, South Africa entered World War II against Germany, and Smuts became prime minister. In 1945, Smuts helped found the United Nations. He was defeated in the 1948 election. John Lambert

Snail is an animal whose soft body is usually covered with a coiled shell. A snail creeps along on a muscular organ called a *foot.* Its body has a head with *tentacles* (feelers), eyes, a mouth, and teeth. There may be more than 80,000 kinds of snails. Some are smaller than a pinhead. Others grow 2 feet (61 centimeters) long.

Snails live almost everywhere—in forests, deserts, rivers, ponds, and all parts of the ocean. They eat many kinds of food. Many snails that live on land eat rotting plants. Snails that live in rivers and lakes feed on water plants and dead animals. Some ocean snails feed on seaweeds, and some eat other sea animals. A few ocean snails are *parasites,* and live in the flesh of starfish or inside sea animals called corals. Snails may live from 2 to 20 years. Many snails that live on land have male and female sex organs in the same animal. Most of those that live in water are either male or female.

Groups of snails. Snails can be divided into three groups, according to where they live: on *land,* in *fresh water,* or in *salt water.*

Land snails are found in damp, shady places—under logs and stones, at the edges of ponds and rivers, and in woods. Most land snails live on the ground. But in tropical forests, many large, colorful kinds are found in the trees. All land snails have lungs.

The land snail uses its muscular foot to crawl about. The muscles of its foot move in a backward, wavelike motion that propels the snail forward. A moving snail

E. S. Ross

The giant African snail, one of the largest land snails, grows about 6 inches (15 centimeters) long. Farmers consider this snail a serious pest because it destroys many kinds of plants.

pours out a sticky slime, which helps the snail move. In dry weather, the snail seals itself in its shell with a "door" of dried slime. It rests in this condition, called *estivation,* until the dry spell ends.

Freshwater snails live in rivers, ponds, lakes, and hot springs. There are about 5,000 kinds of freshwater snails. Some of them have lungs and must come to the surface to breathe the oxygen in air. Others have gills, which take in oxygen from the water.

Saltwater or marine snails are the largest group of snails. There are about 55,000 kinds of snails. Some kinds live along the seashore. Some kinds live on the ocean floor in the deepest parts of the ocean. Most marine snails have gills. Many of these marine snails have a shelly lid, called an *operculum,* which seals the animal in whenever it draws itself into its shell. Shell collectors prize the colorful shells of various saltwater snails.

Useful and harmful snails. Many snails are an important food for fish, birds, and crustaceans, such as crayfish and lobsters. Many people consider the *Helix* garden snail, which is known as *escargot,* a great delicacy. The *turban snail* of Australia was once commonly used to make pearly shirt buttons.

Certain freshwater snails of the tropics carry worms that cause *schistosomiasis,* a disease that kills thousands of people each year. The *giant African snail* destroys flowers, vegetables, and young rubber plants. This large snail is 6 inches (15 centimeters) long. Native to Africa, it is now also found in Hawaii and the Miami area of Florida. Some kinds of *cone shells* of the Indian and Pacific oceans have specialized teeth that can inject *venom* (poison) into small fish and other prey. The venom paralyzes or kills the prey. The venom can also kill people. The sea snails that people eat can carry such diseases as typhoid fever and hepatitis, if they are taken from polluted water.

Robert Robertson

Scientific classification. Snails belong to the class Gastropoda, in the phylum Mollusca. Snails with gills are members of either the subclass Prosobranchia or the subclass Opisthobranchia. Those with lungs are in the subclass Pulmonata.

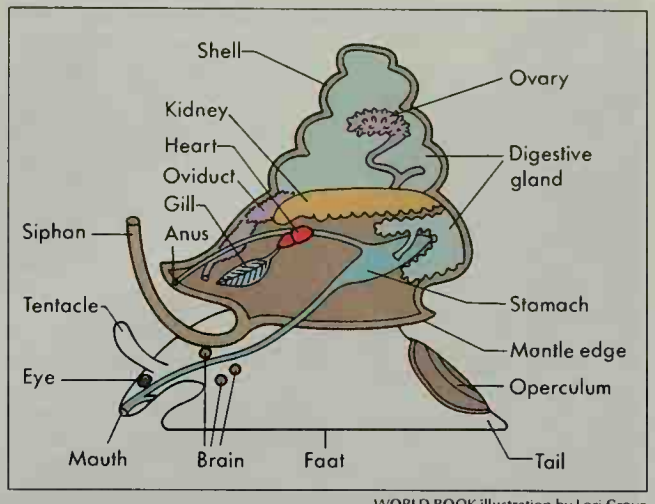
Related articles in *World Book* include:

Abalone	Mollusk (Gastropods)	Shell (pictures)
Conch	Periwinkle	Slug
Cowrie	Schistosomiasis	Whelk
Limpet		

P. Laboute, Jacana

Cone snails live in the Atlantic, Indian, and Pacific oceans. They feed on small sea animals, which they paralyze or kill with their venom. Human beings have died from cone snail bites.

The body of a snail



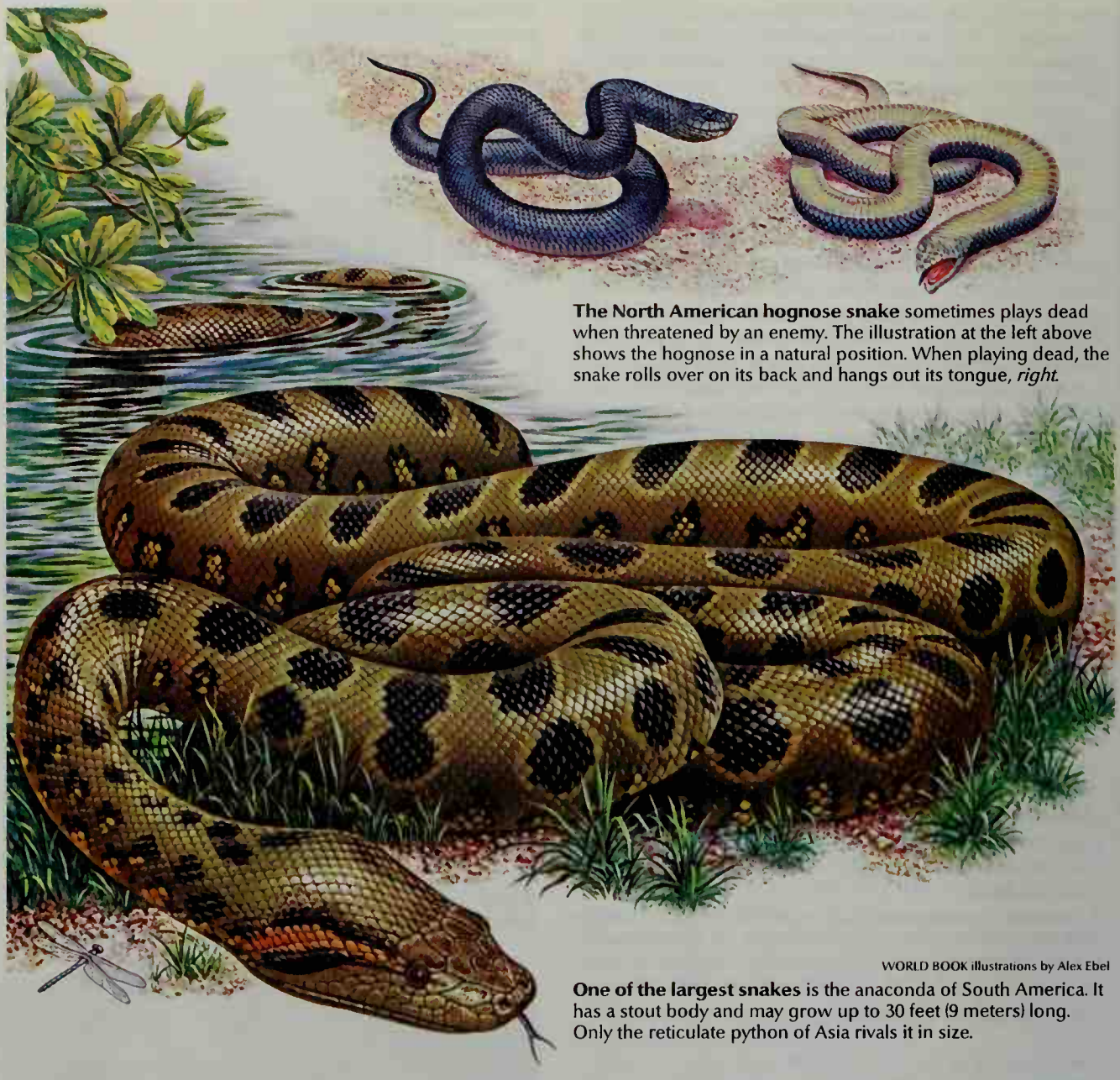
WORLD BOOK illustration by Lori Grove

Lois Cox

A land snail lays a cluster of small, rubbery eggs in a damp place, such as a shallow hole in moist ground.

Grant Heilman from Runk/Schoenberger

The foot and mouth of a freshwater snail can be seen clearly as this creature clings to the side of a glass aquarium. Snails crawl by moving their foot muscles in a wavelike motion.



The North American hognose snake sometimes plays dead when threatened by an enemy. The illustration at the left above shows the hognose in a natural position. When playing dead, the snake rolls over on its back and hangs out its tongue, *right.*

WORLD BOOK illustrations by Alex Ebel

One of the largest snakes is the anaconda of South America. It has a stout body and may grow up to 30 feet (9 meters) long. Only the reticulate python of Asia rivals it in size.

Snake

Snake is an animal with a long, legless body covered by dry scales. To move about on land, a snake usually slides on its belly. Many snakes have such a flexible body that they can coil into a ball. The eyes of a snake are covered by clear scales instead of movable eyelids. As a result, its eyes are always open. Snakes have a narrow, forked tongue, which they repeatedly flick out. They use the tongue to bring odors to a special sense organ in the mouth.

Snakes belong to a *class* (group) of animals called *reptiles.* Reptiles also include crocodiles, lizards, and turtles. Like other reptiles, snakes can maintain a fairly steady body temperature by behavioral means. For example, they raise their body temperature by lying in the sun or lower it by crawling into the shade. In contrast, mammals and birds have internal mechanisms that regulate their body temperature.

Scientists have evidence that snakes developed from lizards about 100 million years ago. Snakes resemble lizards more than they do other reptiles. But unlike most lizards, snakes lack legs, movable eyelids, and external ear openings. Their scales and skulls also differ from those of lizards. Because of their special eye structure, snakes are thought to have developed from lizards that burrowed underground. Their loss of legs is also thought to have occurred as a result of this burrowing phase.

Snakes live almost everywhere on the earth. They live in deserts, forests, oceans, streams, and lakes. Many snakes are ground dwellers, and some live underground. Others dwell in trees, and still others spend most of their time in water. Only a few areas in the

Albert F. Bennett, the contributor of this article, is Professor in the Department of Ecology and Evolutionary Biology at the University of California, Irvine.

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Male rattlesnakes battle for the right to mate with a female. The snakes rear up and lunge at each other repeatedly. The combat continues until one snake is forced down and retreats.

Interesting facts about snakes

One of the smallest snakes is the Braminy blind snake, which lives in the tropics and grows only 6 inches (15 centimeters) long. It has tiny eyes that are covered by head scales.

An African Gaboon viper in a zoo once fasted for 2 $\frac{1}{2}$ years. Snakes in zoos sometimes do not eat for 6 months to 3 years.

Gaboon viper

The fastest snake is probably the black mamba of Africa. It was timed moving at the speed of 7 miles (11 kilometers) per hour over a short distance.

Black mamba

The African ball python protects itself from enemies by coiling into a ball with its head in the middle. Many other snakes also use this method of defense.

Ball python

Green tree pythons may be yellow or brown when hatched. Snakes of both colors may hatch from the same batch of eggs. They turn green as they grow older. Green tree pythons live in New Guinea.

Green tree pythons

The spitting cobra of Africa can squirt venom 6 to 8 feet (1.8 to 2.4 meters). The snake aims for the eyes of its enemy. The venom causes a painful, burning sensation and can produce blindness.

Spitting cobra

WORLD BOOK illustrations by Alex Ebel

world have no snakes. Snakes cannot survive where the ground stays frozen the year around. Thus, no snakes live in the polar regions or at high elevations in mountains. In addition, snakes are often absent from islands, including Ireland and New Zealand.

There are about 2,700 species of snakes. The greatest variety dwell in the tropics. The largest snakes are the anaconda of South America and the reticulate python of Asia. Both may grow up to 30 feet (9 meters) long. One of the smallest snakes is the Braminy blind snake, which lives in the tropics and grows only 6 inches (15 centimeters) long. Like other blind snakes, this snake has eyes, but they are covered by head scales. Blind snakes probably can distinguish only light and dark.

Some snakes are poisonous. They have two hollow or grooved fangs in the upper jaw. The snakes inject *venom* (poison) through their fangs when they bite. About 15 percent of all snake species have venom harmful or fatal to human beings. About 25 species cause most of the deaths from snakebites. These include the Indian cobra of southern Asia, the black mamba and the saw-scaled viper of Africa, and the tiger snake of Australia.

Some people fear and dislike snakes, partly because some kinds are poisonous and partly because their appearance and ways of life seem strange. Throughout history, snakes have been the subjects of many myths and superstitions. The fear of snakes results from a lack of knowledge about the animals. Most snakes are harmless to people. In addition, snakes are helpful in controlling rats and other rodents.

Some people keep snakes as pets. However, snakes do not move around much and are hard to train. Many kinds stay hidden most of the time. In addition, some snakes have unusual feeding habits, which makes them difficult to care for and keep in good health.

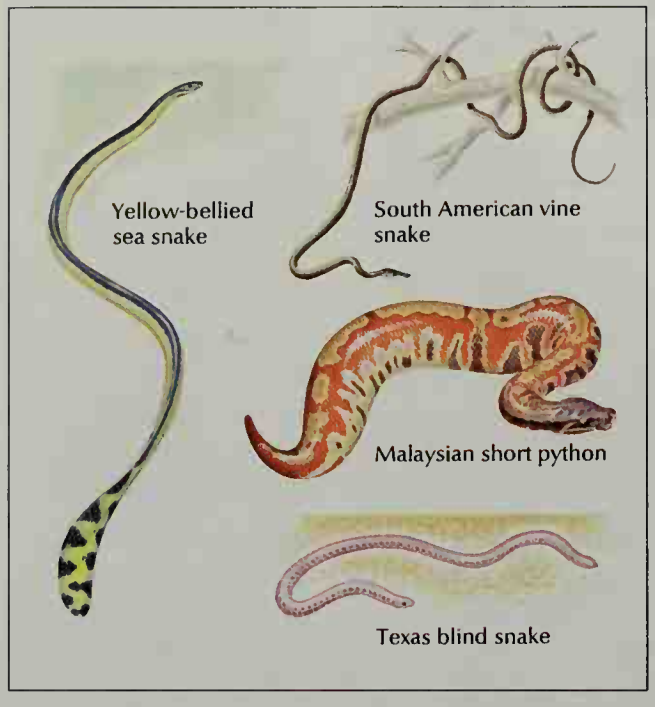
The bodies of snakes

Body shape. Snakes vary greatly in body shape. For example, some snakes, such as the Gaboon viper of Africa, have a stout body. Certain tree snakes, on the other

How body shape differs among snakes

These illustrations show some of the variations in the body shape of snakes. The yellow-bellied sea snake is flattened sideways, and its tail forms an oarlike paddle. Vine snakes have an extremely long, thin body. The Malaysian short python is stubby. The Texas blind snake has a cylindrical body.

WORLD BOOK illustrations by James Teason



hand, have an extremely thin, long body that resembles a vine. The bodies of sea snakes are flattened from side to side.

The males and females of most snake species do not differ greatly in body shape and appearance. However, among some species, the females are larger than the males. In some other species, the males are larger. One species in which the males and females differ greatly in appearance is the langaha of Madagascar. Male langahas have a conelike stub on the snout. The females have a long snout shaped somewhat like a maple leaf.

Scales and color. The body of a snake is covered with dry scales, which may be smooth or have ridges. The majority of snakes have overlapping scales that stretch apart. Among most species, the belly scales, called *scutes,* consist of one row of large scales extending from the neck to the tail. The side and back scales vary in size and shape among different species.

The scaly skin of a snake has two layers. The inner layer of skin consists of cells that grow and divide. The cells die as they are pushed upward by new cells. The dead cells form the outer layer of skin. From time to time, a snake sheds this outer layer because it becomes worn or because the snake's body is growing larger.

The skin-shedding process is called *molting.* For a short time before molting, a snake is less active than usual. The animal's eyes become clouded because the skin covering the eyes is shed along with the rest of the skin. The snake loosens the skin around the mouth and head by rubbing its nose on a rough surface. The snake then crawls out of the old skin, turning it inside out in the process.

How often a snake molts depends chiefly on its age and how active it is. Young snakes shed more often than old ones. Snakes that live in warm climates are active for longer periods than those that live in cooler climates. As a result, they molt more frequently. Some pythons of the tropics shed six or more times a year. In contrast, some North American rattlesnakes average two or three molts a year. A new section may be added to the rattle on the tail each time they molt.

A snake's color comes chiefly from special *pigment cells* in deep layers of the skin. But some color may be due to the way light is reflected from the surface of the scales. The molted skin is pale yellow or white.

Most snakes have a drab coloring that matches their surroundings. For example, the North American copperhead has brown bands that blend with dead leaves on the forest floor where it lives. Some snakes have bright colors. For example, the coral snakes of North America have bright bands of black, red, and yellow or white. In some cases, snakes of the same species have different color patterns. For example, some California king snakes are black with white bands across the width of the body. Others have white stripes that extend the length of the body. Great Plains ground snakes have a wide variety of markings. Some are tan or brown with many red bands, and some have a red band only around the neck. Others have a red stripe down the middle of the back. Still others are solid tan or brown, without any markings.

Skeleton. The main parts of a snake's skeleton are (1) the skull, (2) vertebrae, and (3) ribs. A few snakes, such as blind snakes, boas, and pythons, have *vestiges* of hind legs or hipbones. A vestige is a remaining trace of a body part that a group of animals has lost during evolution through the ages. Snakes that have vestiges of hind legs or hipbones clearly show their close relationship to lizards.

Skull. Most of the bones of a snake's skull are loosely connected. But the brain is completely enclosed by bone.

In most snakes, the lower jaw has two bones connected at the chin by an elastic tissue. These bones can be stretched widely apart. The lower jaw is loosely attached to the upper jaw. Several bones of the upper jaw and roof of the mouth also are loosely joined to one an-

E. R. Degginger

A snake sheds its skin by rubbing its nose on a rough surface, which loosens the skin about the head. It then crawls out of the skin. This snake is a North American rainbow water snake.

other and to the rest of the skull. The two sides of a snake's jaws can be moved separately. Some bones of the lower and upper jaws have pointed teeth that curve back toward the throat. These teeth are not suitable for chewing, and so snakes swallow their prey whole. Most snakes also eat their prey while it is alive.

The structure of their jaws enables most snakes to open the mouth wide and swallow animals that are larger than their own head. Some large pythons can swallow animals that weigh more than 100 pounds (45 kilograms). To swallow an animal, a snake moves first one side of its jaws forward and then the other side. The snake's curved teeth stick into the prey and prevent it from escaping. As the snake alternately draws each side of its jaws backward, it pulls the animal toward the throat. Some saliva is produced in the snake's mouth and throat, which eases the passage of the animal.

In some cases, a snake may take more than half an hour to swallow an animal. A special feature prevents the *trachea* (windpipe) from being blocked while the snake's mouth and throat are full. The trachea can be pushed forward over the tongue and out the mouth so that the snake can breathe while swallowing.

Vertebrae. The backbone of snakes consists of an unusually large number of vertebrae. Snakes have about 150 to over 430 vertebrae, depending on the species. Strong, flexible joints connect the vertebrae and enable the body to make a wide range of movements, including rolling into a ball.

Ribs. A pair of ribs is attached to each vertebra in front of the tail. The ribs are not joined together along the belly and so can be extended outward. After a snake has swallowed a bulky meal, the ribs thus spread out as the stomach expands.

Muscles. As many as 24 small muscles are attached to each vertebra and rib in a snake's body. These muscles connect one vertebra to another, the vertebrae to the ribs, one rib to another, and the ribs to the scales. Snakes use most of these muscles to move about. The section *Methods of movement* describes the ways in which snakes move.

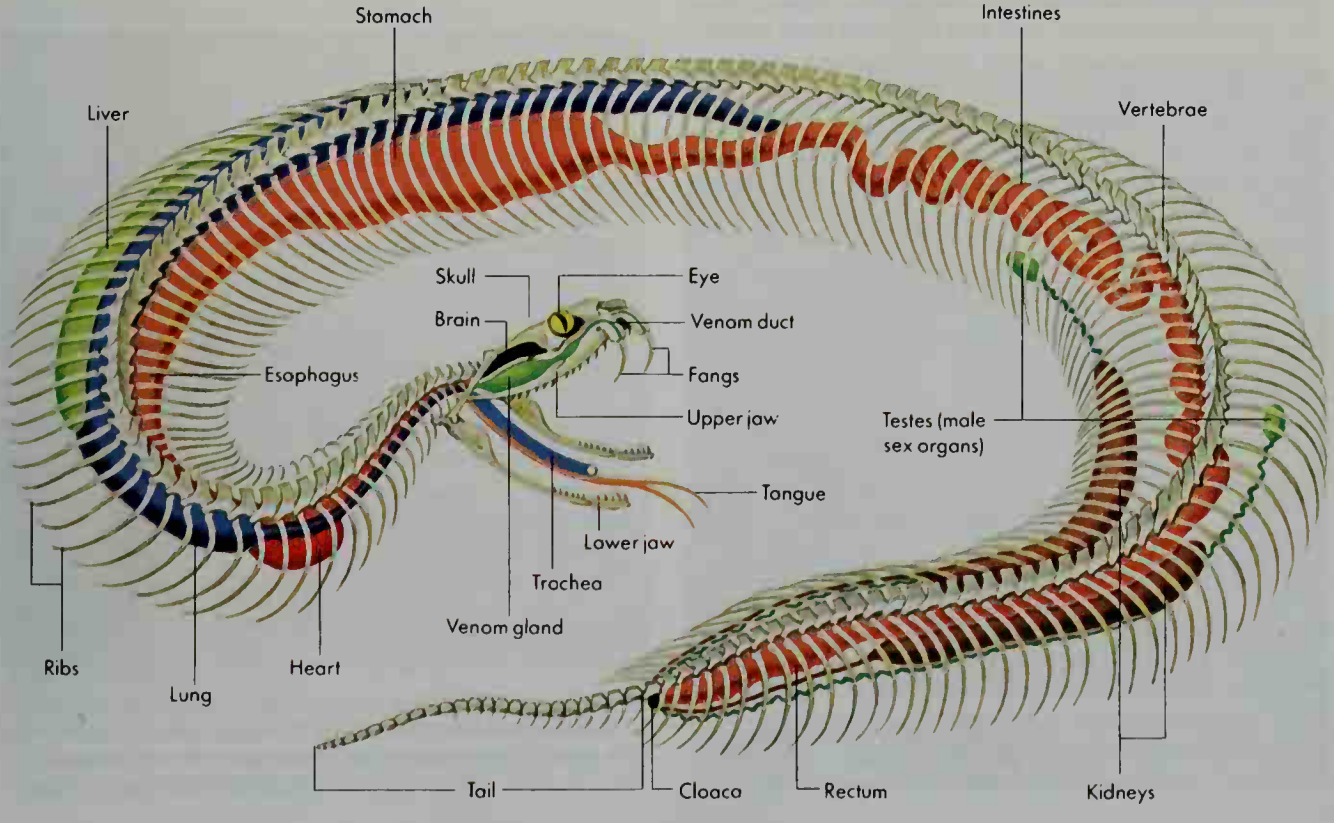
Internal organs. The lung, liver, and other major internal organs of snakes are long and slender. Most snakes have only one lung, though many have a vestige of another lung. Their paired organs—the kidneys and *ovaries* (female sex organs) or *testes* (male sex organs)—are arranged one on each side of the body. But each pair is staggered from front to back. In most other animals, they are positioned one directly across from the other.

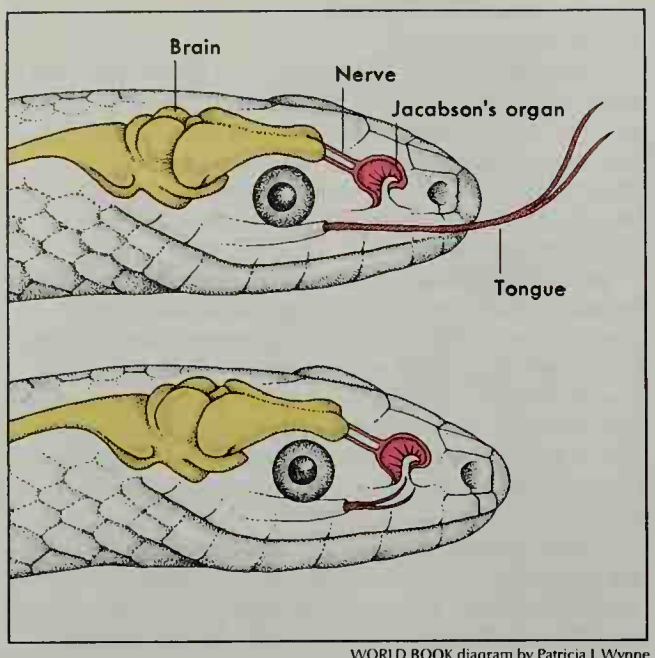
In most snakes, the digestive system, which includes the stomach and intestines, is specially suited for handling bulky food. The stomach can expand greatly. Substances called *enzymes* are produced in the intestines. These enzymes break down food into materials that can be absorbed. Snakes can digest the entire body of their prey, except for hair or feathers. Bone may be completely digested within 72 hours. Waste products pass out of a snake's body through a cavity called the *cloaca* and out of an opening called the *vent*. In female snakes, the cloaca is also the cavity into which the *oviducts* (tubes from the ovaries) empty. In both males and females, the vent marks the end of the snake's trunk and the beginning of its tail.

The anatomy of a snake

This drawing of a male water moccasin shows the skeleton and internal organs. A snake's skeleton consists of a skull and many vertebrae and ribs. Most of the animal's internal organs are long and thin. Only poisonous snakes have fangs and venom glands.

WORLD BOOK diagram by James Teason





WORLD BOOK diagram by Patricia J. Wynne

The Jacobson's organ in snakes is used with the tongue to detect odors. The snake flicks out its tongue and picks up scent particles, *top*. When the snake pulls in its tongue, the particles are transferred to the odor-sensitive Jacobson's organ, *bottom*.

Snakes that eat large meals use up a huge amount of energy during and after digesting food. Their intestines, liver, and other internal organs shrink between meals, and the snakes' bodies must rebuild these organs to their full size before they can digest new food.

Sense organs. Snakes do not have especially keen senses of sight or hearing. They rely mainly on special sense organs to provide them with information about their environment.

Snakes have an eye on each side of the head, which gives the animals a wide field of view. Clear scales cover the eyes. The scales are shed and replaced each time a snake molts. Snakes can easily see movements. But they cannot focus their eyes well, and they have good vision for only a short distance.

Snakes lack outer ear openings. However, they have inner ears and can hear a limited range of sounds carried in the air. Certain bones in a snake's head respond to sound waves and transmit them to the inner ear.

A snake's tongue has few taste buds. The tongue is used with an organ of smell called the *Jacobson's organ*. The Jacobson's organ, along with the nostrils, provides snakes with a keen sense of smell. The Jacobson's organ consists of two hollow sacs in the roof of the mouth. The sacs have many nerve endings that are extremely sensitive to odors. A snake sticks out its tongue to pick up scent particles in the air or on the ground or some other surface. When the snake pulls its tongue back into the mouth, these particles enter the Jacobson's organ. The organ enables a snake to follow the scent trail of its prey. In addition, a male snake can follow the trail of a female snake by using its tongue and Jacobson's organ.

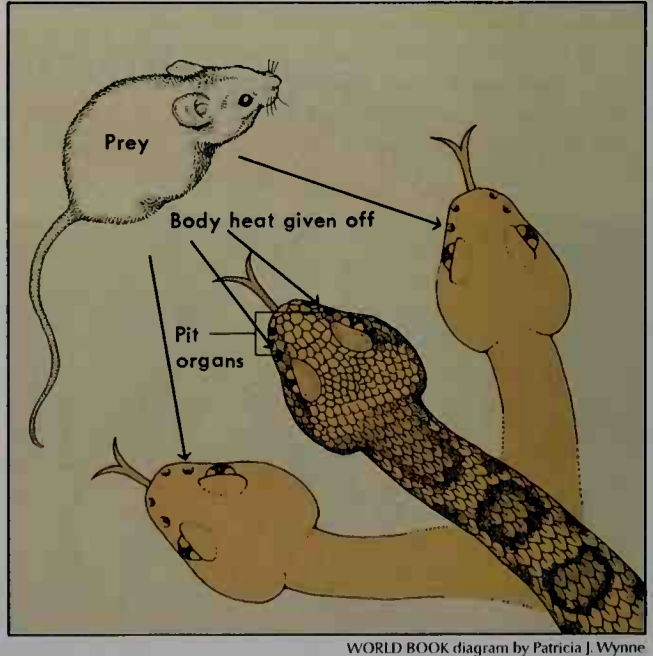
Certain snakes have special heat-sensitive *pit organs*. Pit vipers have two pit organs, one on each side of the head between the eye and nostril. Some boas and pythons have many pits along the lip of the upper jaw. Pit organs enable a snake to detect the exact location of a warm-blooded animal by the body heat it gives off. Thus, the snake can accurately direct its strike at warm-blooded prey even in the dark. A snake with pit organs can sense a change in temperature near its head of less than 1 °F (0.5 °C).

Researchers have found it difficult to test the intelligence of snakes. The animals are hard to train, partly because they feed infrequently and so cannot be rewarded easily with food for performing correctly. In the few intelligence experiments that have been conducted, snakes showed little learning ability. However, most experiments did not test abilities important to the snakes' way of life. For example, the ability to learn mazes might be useful to burrowing snakes. But burrowing snakes were not used in the experiments that tested this skill.

Fangs and venom glands. Only poisonous snakes have fangs and venom glands. Venom glands developed from *salivary glands* (glands that produce saliva). Poisonous snakes bite a victim with their fangs and inject venom into the wound. They use their fangs and venom chiefly to kill prey. In addition, enzymes in the venom speed up the digestion of the animal eaten.

Some groups of snakes have fangs in the front of their mouth. Other groups use their back teeth as fangs. Most poisonous snakes are front-fanged. The two teeth closest to the front of the mouth in the upper jaw form hollow fangs. The fangs are similar to hypodermic needles and may be shed and replaced several times a year. A narrow tube connects each fang to a venom gland on each side of the upper jaw.

The fangs differ between the two main groups of poisonous snakes—*vipers* and *elapids*. Vipers, which include copperheads and rattlesnakes, have long, movable front fangs. When not in use, the fangs fold back into a sheath on the roof of the mouth. When the snake strikes, the fangs are erected. Elapids, which include cobras and coral snakes, have short front fangs that are



WORLD BOOK diagram by Patricia J. Wynne

Pit organs enable a snake to locate warm-blooded prey by the body heat the animal gives off. As the snake moves its head from side to side, the pit organs detect changes in the air temperature. The snake can accurately direct its strike even in the dark.

fixed in place. Sea snakes have the same type of fangs that elapids have.

Some venomous snakes have one to three grooved fangs on the upper jaw in the rear of the mouth. Most of these rear-fanged snakes are not dangerous to human beings because they cannot inject venom rapidly into large animals.

A snake's venom glands produce a number of enzymes and other substances that can cause death. After a snake bites its prey, some of these enzymes begin the process of digestion even before the snake begins to swallow the animal. However, the snake usually waits for the venom to kill the animal before swallowing it.

In addition to enzymes, most snake venoms contain two kinds of poisons—*neurotoxins* and *hemotoxins*. Neurotoxins affect the nervous system. They cause difficulties in breathing and swallowing and disrupt the work of the heart. Hemotoxins damage blood vessels and body tissues. Sea snakes have an unusual type of venom that directly affects the muscles.

There is no easy way to distinguish all poisonous snakes from nonpoisonous ones. A person must either recognize the features of specific species or see whether the snake has fangs. For information on the treatment of snakebites, see the article **Snakebite**.

Ways of life among snakes

Snakes are difficult to observe in their natural surroundings because they stay hidden much of the time. Little is known about the ways of life among many species. Scientists who study snakes and other reptiles and amphibians are called *herpetologists*. They have detailed information about the behavior of only a few species of snakes.

In general, the life of a snake consists mainly of moving about alone in search of food or a mate. Most snakes are active during the day. Others move about at night and rest during the day. Snakes are sometimes inactive for long periods because of cold or hot weather or a scarce supply of food. Some snakes stay within a very limited area. For example, a study of prairie rattlesnakes showed that the males roamed an area about $\frac{3}{4}$ mile (1.2 kilometers) in diameter. The females roamed an area about $\frac{1}{6}$ mile (0.27 kilometer) in diameter.

Methods of movement. Snakes often appear to slither swiftly across the ground. But they actually move slowly compared with many other animals. Garter snakes, pythons, and some other snakes have been timed at a speed of only 1 mile (1.6 kilometers) per hour. The fastest speed on record is that of an African black mamba. It was timed at a speed of 7 miles (11 kilometers) per hour over a short distance. In comparison, human beings can easily run short distances at 10 to 15 miles (16 to 24 kilometers) per hour.

Snakes have four main methods of moving about. They are (1) lateral undulation, (2) rectilinear movement, (3) concertina movement, and (4) sidewinding. Some snakes also move in other, unusual ways.

Lateral undulation is the most common way in which snakes move about. The snake flexes its muscles and so produces a series of horizontal waves from head to tail. The loops of its body push against plants, rocks, twigs, or rough areas on a surface. In this manner, the snake's body is propelled forward.

All snakes can swim by producing the wavelike motions typical of lateral undulation. But sea snakes have a body shape that makes them especially good swimmers. The body is flattened from side to side, and the tail forms an oarlike paddle.

Rectilinear movement is also known as creeping. Snakes often use this method to climb trees or move through narrow burrows. In addition, many thick-bod-

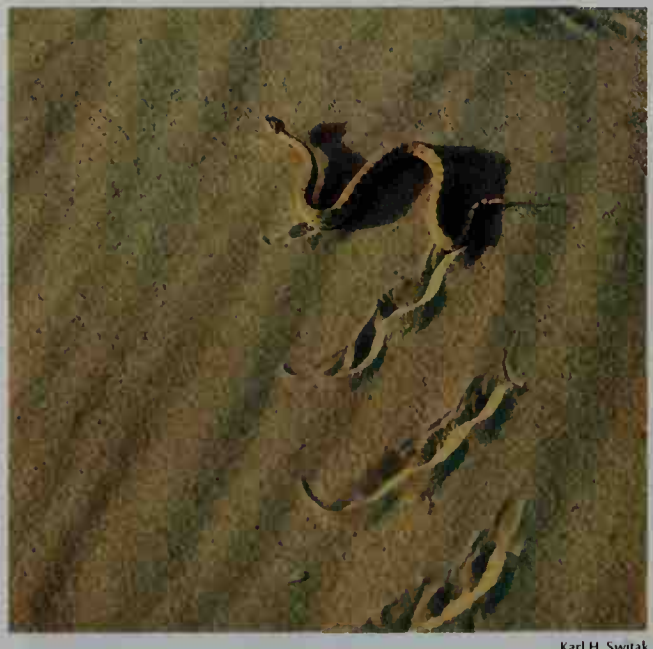
Some ways snakes move about

Allan Power, Bruce Coleman Inc.

In lateral undulation, a snake moves its body in a series of horizontal waves. Snakes make these wavelike motions to move on the ground or, like the banded sea snake above, to swim.

Clem Haagner, Bruce Coleman Inc.

In rectilinear movement, the snake's body is kept straight. The snake crawls by pulling its belly scales forward and then pushing them backward. This snake is an African puff adder.



Karl H. Switak

In sidewinding, a snake uses its head and tail as supports and lifts its trunk sideways. This North American sidewinder leaves distinctive tracks as it moves across the sand.

ied snakes, such as puff adders and pythons, may use rectilinear movement when crawling along on the ground.

In rectilinear movement, the snake contracts certain muscles that pull its belly scales forward. The back edges of the scales catch on bark or rough areas in the soil. The snake then contracts other muscles, which pushes the scales against the bark or rough areas and so moves the body forward.

Rat snakes and many other climbing snakes have belly scales especially suited to rectilinear movement. The edges of the scales are squared, and they easily catch on bark as the snake creeps up a tree.

Concertina movement is often used by snakes to climb through trees or move over smooth surfaces. The snake moves the front part of its body forward and coils it slightly, pressing against the surface to anchor itself. The snake then pulls its back end forward and coils it. The back end is pressed down, providing leverage for the front part to move forward again.

Sidewinding is used chiefly by certain snakes that live in areas with loose soil or sand. These snakes include the sidewinder of North America and the carpet viper and horned viper of Africa. In sidewinding, the snake's head and tail serve as supports. The snake lifts the trunk of its body off the ground and moves it sideways. The snake then moves its head and tail into position with the rest of its body. It then repeats the sequence.

Unusual ways of moving. Many small species of snakes seem to "jump" when trying to escape from danger. They hurl the body forward or to the side by rapidly straightening up from a coiled position. Two gliding snakes of southern Asia can "parachute" from a high limb to a lower one or from one tree to another. They spread their ribs, which flattens the body and so helps slow the fall.

Reproduction. All snakes reproduce sexually. In sexual reproduction, a *sperm* (male sex cell) unites with an *egg* (female sex cell), forming a *fertilized egg.* The fertilized egg develops into a new individual.

Male snakes have a pair of sex organs called *hemipenes.* They lie inside the tail and can be pushed out through the vent. During mating, the male curls his tail under the female's, inserts either hemipenis into her cloaca, and deposits sperm. Among some species, the sperm can live within the female's body from several months to more than a year. Thus, the eggs may become fertilized long after mating occurs. Male and female snakes do not stay together after mating.

In regions that have warm summers and cold winters, most snakes mate in the spring or fall. In the tropics, snakes may mate at any time of the year.

Most snakes lay eggs. The females generally lay them in shallow holes, rotten logs, tree stumps, or similar places. Sometimes, 100 or more females will lay their eggs at the same site. The number of eggs a female lays at one time varies greatly among different species. In many species, the female lays 6 to 30 eggs at a time. Large pythons usually lay about 50 eggs, but they occasionally produce more than 100.

Most female snakes leave their eggs after laying them. But among a few species, including Indian pythons and king cobras, the females may coil on top of their eggs and guard them. Large pythons are the only snakes that incubate their eggs. The female python curls her body around the eggs and contracts her muscles to produce heat if the temperature is cool. In this way, she is able to keep her eggs as warm as 85° F. (29° C), which aids in hatching them.

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Snakes hatching from eggs. Among most species of snakes, the young hatch from eggs outside the mother's body. The snakes shown above are northern pine snakes of North America.

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A female snake giving birth to live young. About a fifth of all species of snakes bear live young. The mother and newborn above are northern copperheads of North America.

The shells of snake eggs are leathery and expand as the young grow inside. The young snakes hatch in about 8 to 10 weeks. The females of some species carry their eggs within the body several weeks before laying them. As a result, the eggs are well developed by the time they are laid and hatch within 2 to 4 weeks. When they are ready to hatch, young snakes slash their shells with a special tooth that grows on the upper jaw. The tooth is shed after the snakes crawl out of their shells.

About a fifth of all species of snakes bear live young. The pregnancy period among most of these species lasts about two or three months. Some species have more than 100 young at a time, but most bear far fewer.

Newly hatched or newly born snakes are entirely on their own and must find their own food. They grow rapidly. The young of some species reach maturity—that is, are able to reproduce—in one year. Among other species, the young mature in two to four years. Most snakes continue to grow after reaching maturity.

Regulation of body temperature. The body temperature of snakes varies with changes in the temperature of their surroundings. However, a snake's body

temperature must be kept within a certain range for the animal to survive. Most snakes can be fully active only if their body temperature measures between 68 and 95 °F (20 and 35 °C). They cannot move if their temperature drops below about 39 °F (4 °C). On the other hand, most snakes will die if they are exposed to temperatures above 104 °F (40 °C).

Snakes maintain their body temperature within the necessary range by moving to warmer or cooler places. Most of them raise their body temperature by lying in the sun. Snakes that live underground move to warmer areas in the soil or under rocks. Snakes avoid high temperatures by seeking shelter under bushes, logs, or rocks. Some snakes in the tropics spend the hottest part of the year in a state of limited activity called *estivation*.

Snakes that live in regions with cold winters hibernate and so avoid freezing. They spend the winter in caves, holes in the ground, or other frost-free places. In most areas of the world, a snake sheltered 3 feet (91 centimeters) below the surface of the ground would be protected from freezing. During hibernation, a snake's body temperature may measure from about 39 to 41 °F (4° to 5 °C).

Hundreds of snakes of different species may hibernate in the same place, called a *hibernaculum*, if suitable sites are scarce. In the fall and spring, they may be seen near these sites warming themselves in the sun.

Feeding habits. Most snakes eat birds, fish, frogs, lizards, and such small mammals as rabbits and rats. Some snakes, including Asian king cobras and North American king snakes, eat other snakes.

Numerous snakes have highly specialized feeding habits. For example, some species eat chiefly snails. The teeth and lower jaw of some snail-eating snakes are specially adapted for pulling the snails from their shells. Thread blind snakes, which closely resemble blind snakes, have a tiny mouth and eat mainly termites. These snakes can suck the insides of the abdomen from a termite's body, leaving the less digestible parts. Certain snakes that eat eggs have long spines inside the throat on the neck vertebrae. After a snake swallows an egg, the shell is pierced by these spines and then crushed by the snake's muscle contractions. The contents of the egg pass through the throat, but the vertebral spines prevent the passage of the shell. The snake then spits out the shell.

Snakes have various ways of capturing prey. They may wait in ambush, stalk the animal, or pursue it. When a snake strikes, it lunges toward the animal with its mouth wide open. A snake's strike usually is effective only up to a distance equal to one-half to two-thirds of its body length.

Most snakes swallow their prey alive. However, poisonous snakes generally wait for their venom to kill an animal before they swallow it. *Constrictors* also kill their prey before eating it. Constrictors include boas, bull snakes, king snakes, pythons, and rat snakes. A constrictor wraps two or more loops of its body around an animal and then contracts its muscles, squeezing the animal. A number of people believe that constrictors kill by crushing the bones and internal organs of their victims. Actually, constrictors kill animals by causing them to suffocate.

After feeding, a snake may lie in the sun. The warmth

How a snake swallows its prey

The pictures below show a North American corn snake eating a mouse. The snake begins to swallow the mouse headfirst, *top picture*. Its scales stretch apart and its ribs spread out as it swallows the animal. It alternately moves each side of its jaws forward and backward, pulling the mouse through its throat, *center*. The mouse slides through the snake's esophagus, *bottom*.

© Zig Leszczynski, Animals Animals

raises its body temperature, which speeds up the process of digestion. A meal may last a snake a long time. Snakes in zoos and laboratories sometimes do not eat for a few weeks. Large snakes, such as boas and pythons, may go without food for a whole month. Occasionally, some large snakes will fast for more than a year.

Snakes can survive a long time without food for several reasons. Unlike warm-blooded animals, snakes do not need much food energy to maintain a steady body temperature. Snakes also may remain inactive for extended periods and so use up little energy. In addition, snakes have extensive tissues that store fat. During long fasts, they live off this fat.

Protection against enemies. Many kinds of animals prey on snakes. These predators include large birds, such as bustards and serpent eagles; certain mammals, such as mongooses and pigs; and certain other snakes, such as king cobras and king snakes.

Snakes have a wide variety of defenses against predators. Many species have color patterns that match their surroundings and so help conceal them. If threatened by a predator, a snake may escape simply by fleeing into a burrow, pond, or some other place where the animal cannot follow. Some shield-tailed snakes of southern Asia can block the entrance to their burrow. They have a short, blunt tail, which they wedge against the opening.

Many snakes make threatening noises when a predator approaches. Some can hiss loudly by expelling air from the lung. The rattlesnake makes a distinctive whirring sound by vibrating its tail rattle. The African saw-scaled viper produces a rasping sound by rubbing its side scales together.

Some snakes change their appearance and adopt a threatening posture that may frighten away predators. For example, the cobra lifts its neck and spreads its ribs, forming a broad hood. North American hognose snakes, indigo snakes, and some other species spread the neck ribs and inflate the lung, which makes them look larger and fiercer.

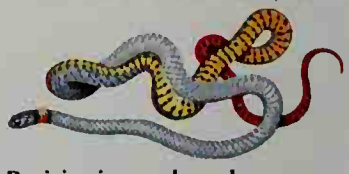
Many animals that prey on snakes have no interest in dead snakes. Thus, certain snakes defend themselves

Some harmless snakes of North America

WORLD BOOK illustrations by James Teason

Eastern garter snake
Thamnophis sirtalis sirtalis
18 to 26 inches (46 to 66 centimeters) long

Eastern coachwhip
Masticophis flagellum flagellum
42 to 60 inches (107 to 152 centimeters) long



Prairie ringneck snake
Diadophis punctatus arnyi
10 to 14 inches (25 to 36 centimeters) long

Sonora Mountain kingsnake
Lampropeltis pyromelana
18 to 41 inches (46 to 104 centimeters) long

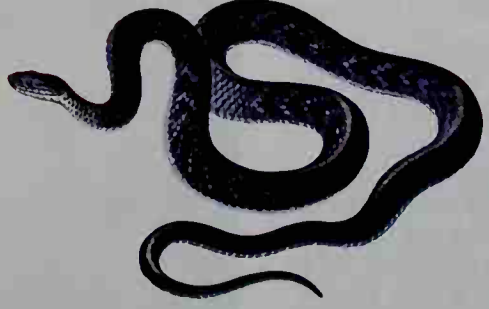
Bull snake
Pituophis melanoleucus sayi
50 to 72 inches (127 to 183 centimeters) long

Eastern yellow-bellied racer
Coluber constrictor flaviventris
30 to 50 inches (76 to 127 centimeters) long

Rough green snake
Opheodrys aestivus
22 to 32 inches (56 to 81 centimeters) long

Corn snake
Elaphe guttata guttata
30 to 48 inches (76 to 122 centimeters) long

Red milk snake
Lamprupeltis triangulum syspila
21 to 28 inches (53 to 71 centimeters) long



Black rat snake
Elaphe obsuleta obsuleta
42 to 72 inches (107 to 183 centimeters) long

Northern water snake
Nerodia sipedun sipedon
24 to 42 inches (61 to 107 centimeters) long

by playing dead. The North American hognose snake is especially well known for such behavior. The African ball python protects itself by coiling into a tight ball with its head in the middle. This defense is also used by North American ground snakes, rubber boas, and various other species.

Some harmless snakes resemble poisonous snakes and thus may gain protection from enemies that fear poisonous snakes. In addition, some kinds of harmless snakes imitate the behavior of poisonous snakes. For example, king snakes and rat snakes vibrate the tail among dry leaves and thereby produce a sound like that made by rattlesnakes. Some harmless snakes of Africa imitate the rasping sound of the saw-scaled viper by rubbing their side scales together. Certain harmless Asian snakes spread their ribs and form a hood like that of the Indian cobra.

If other defenses fail, a snake might attack and bite an enemy. The bite of a poisonous snake is an especially powerful weapon. But the snake could be seriously clawed or bitten before its venom takes effect. The African "spitting" cobra has added protection. It can squirt venom into the eyes of an enemy 6 to 8 feet (1.8 to 2.4 meters) away. The venom causes an immediate painful, burning sensation and can produce blindness. Large constrictors are also a powerful match for most of their enemies. They can quickly coil around an animal and suffocate it, just as they do prey.

Battles among male snakes. Among some species of snakes, the adult males sometimes fight one another. In a typical battle, two snakes rear up, entwine their bodies, and try to push each other down. The combat continues until one snake gives up and retreats. Such battles are especially common among vipers. But they also occur among such small, harmless snakes as North American ground snakes and European smooth snakes.

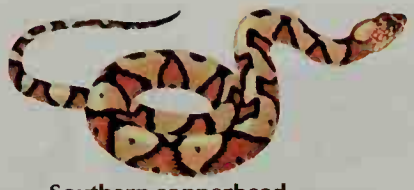
Herpetologists do not know for certain why male snakes of some species fight one another. But most of the fights occur during the breeding season. They may be caused by rivalry over a mate or feeding area.

Life span. Herpetologists do not know how long snakes live in the wild. Most snakes in zoos do not live

Some poisonous snakes of North America

WORLD BOOK illustrations by James Teason

Northern copperhead
Agkistrodon contortrix mokason
24 to 36 inches (61 to 91 centimeters) long



Southern copperhead
Agkistrodon contortrix contortrix
24 to 36 inches (61 to 91 centimeters) long

Broad-banded copperhead
Agkistrodon contortrix laticinctus
22 to 30 inches (56 to 76 centimeters) long

Western pygmy rattlesnake
Sistrurus miliarius streckeri
15 to 20 inches (38 to 51 centimeters) long

Eastern diamondback rattlesnake
Crotalus adamanteus
33 to 72 inches (84 to 183 centimeters) long

Black-tailed rattlesnake
Crotalus molossus molossus
30 to 42 inches (76 to 107 centimeters) long

Timber rattlesnake
Crotalus horridus horridus
36 to 54 inches (91 to 137 centimeters) long

Eastern cottonmouth
Agkistrodon piscivorus piscivorus
30 to 48 inches (76 to 122 centimeters) long

Eastern massasauga
Sistrurus catenatus catenatus
20 to 30 inches (51 to 76 centimeters) long

Canebrake rattlesnake
Crotalus horridus atricaudatus
42 to 60 inches (107 to 152 centimeters) long

Eastern coral snake
Micrurus fulvius fulvius
20 to 30 inches (51 to 76 centimeters) long

longer than 15 years. But some have lived 20 years in captivity, and a few have lived over 30 years.

Classification of snakes

There are about 2,700 species of snakes. They are classified into various families, based chiefly on common skeletal features. Most herpetologists divide snakes into 15 families. The scientific name of each family is given in parentheses after the common name.

Blind snakes (Typhlopidae) consist of about 200 species. They burrow underground and eat mainly ants and termites. Blind snakes look much like earthworms, though some species may grow almost 3 feet (90 centimeters) long. Their eyes are covered by the head scales. Most blind snakes live in tropical and subtropical regions.

Boids (Boidae) consists of about 70 species, most of which have large, stout bodies. The anaconda can reach more than 30 feet (9 meters) in length. However, sand boas may grow less than 3 feet (90 centimeters) long. Most boids have external vestiges of hind legs. The majority of boids live in tropical and subtropical regions. Different species dwell on land, in trees, or in water.

Burrowing asps (Atractaspididae), also called stiletto snakes, are a family of about 55 species in Africa and the Middle East. These venomous snakes live underground and eat either burrowing mammals or reptiles.

Colubrids (Colubridae) total about 1,800 species. They make up about two-thirds of all species of snakes. The family includes most of the common harmless snakes, such as the North American garter snakes and rat snakes. It also includes many species of venomous, rear-fanged snakes. However, only a few rear-fanged snakes, such as the African bird snakes and boomslangs, are dangerous to human beings.

Colubrids live throughout most of the world. The different species vary greatly in appearance and ways of life. They dwell on land, in trees, in water, or under the ground.

Elapids (Elapidae) consist of over 250 species of venomous snakes. All have short, nonmovable front fangs. Elapids are most numerous in Australia, where they include the Australian black snake, death adder, taipan, and tiger snake. The cobras of Africa and Asia, the kraits of southern Asia, the mambas of Africa, and the sea snakes of the Indian and Pacific oceans are also elapids.

WORLD BOOK illustrations by James Teason

Some snakes of other continents

Boa constrictor (nonpoisonous)
Boa constrictor
11 feet (3.4 meters) long
Central and South America

Saw-scaled viper (poisonous)
Echis carinatus
1 $\frac{1}{3}$ to 2 $\frac{1}{3}$ feet (0.41 to 0.71 meter) long
Africa and Asia

Asp viper (poisonous)
Vipera aspis
1 $\frac{1}{2}$ to 2 $\frac{1}{2}$ feet (0.46 to 0.76 meter) long
Europe

Paradise tree snake (nonpoisonous)
Chrysopelea paradisi
3 to 4 feet (0.9 to 1.2 meters) long
Southeast Asia

Banded krait (poisonous)
Bungarus fasciatus
4 to 7 feet (1.2 to 2.1 meters) long
Asia

Taipan (poisonous)
Oxyuranus scutellatus
10 to 13 feet (3 to 4 meters) long
Australia

Boomslang (poisonous)
Dispholidus typus
4 $\frac{1}{2}$ to 6 feet (1.4 to 1.8 meters) long
Africa

King cobra (poisonous)
Ophiophagus hannah
12 to 18 feet (3.7 to 5.5 meters) long
Asia

Carpet python (nonpoisonous)
Morelia spilotes
6 $\frac{1}{2}$ to 13 feet (2 to 4 meters) long
Australia

File snakes (Acrochordidae), also called wart snakes, consist of three species. Each species has a stout body and wrinkled skin. These snakes grow up to 8 feet (2.4 meters) long and are widely hunted for their leatherlike skin. They live in the rivers and coastal waters of southern Asia, northern Australia, and the South Pacific islands.

The Mexican burrowing snake (Loxocemidae) is a single species that comprises its own family. The snake lives in Mexico and Central America. It has mostly brown coloring with a white belly. The snake eats turtle and lizard eggs, in addition to small mammals and other reptiles.

The pipe snake (Aniliidae) is a single species of burrowing snake that makes up its own family. It has a stout body that grows less than 3 feet (90 centimeters) long. The pipe snake lives in South America.

Primitive blind snakes (Anomalepididae) are small wormlike snakes that live in leaf litter on the floor of rain forests in Central and South America. They eat small insects and worms. They are closely related to blind snakes. There are about 20 species known.

Pythons (Pythonidae) are a group of about 30 species of large snakes from Africa, Asia, and Australia. They occur in a wide variety of habitats, from rain forests to dry scrub. Most species live on the ground, although some reside in trees or in water. Pythons eat warm-blooded animals, and most species have heat-sensitive pits on their faces to locate prey.

Round Island boas (Bolyeriidae) consist of two species that live on islands in the Indian Ocean. These snakes grow up to 50 inches (130 centimeters) long. They have unusual upper jawbones that are divided into movable front and back parts. Round Island boas rank among the world's most endangered species.

Shield-tailed snakes (Uropeltidae) consist of about 45 species of burrowing snakes, all of which live in Sri Lanka and southern India. They have a highly pointed or wedge-shaped snout; a short, blunt tail; and smooth scales. Most species of shield-tailed snakes dwell in humid mountain forests.

Sunbeam snakes (Xenopeltidae) consist of one species. The snakes live in southeastern Asia. They have highly polished scales, which sparkle in the sunlight. They usually stay under logs or stones or in burrows during the day and move about at night.

Thread blind snakes (Leptotyphlopidae), also called worm snakes, make up about 80 species. They closely resemble blind snakes and have similar ways of life. A main difference between the two families is that blind snakes have teeth only on the upper jaw, and thread blind snakes have teeth only on the lower jaw. Thread blind snakes live in Africa, southern Asia, southwestern North America, and tropical areas of Central and South America.

Vipers (Viperidae) have long fangs attached to the front of the upper jaw. The upper jaw rotates, enabling a viper to move its fangs forward and backward.

The fangs of vipers are much longer than those of elapids. The African Gaboon viper has perhaps the longest fangs of any venomous snake. They may grow up to 2 inches (5 centimeters) long.

Vipers are divided into two main groups – *pit vipers* and *true vipers*. Pit vipers have pit organs between their eyes and nostrils. They consist of about 100 species, which are found on all the continents except Antarctica and Australia. Pit vipers include North American copperheads, rattlesnakes, and water moccasins. True vipers do not have pit organs. They consist of about 50 species, which live in Africa, Asia, and Europe. True vipers include the Gaboon viper and the European viper.

The importance of snakes

The main value of snakes is that they form part of the environment and help preserve the balance of nature (see **Balance of nature**). But people also gain economic benefits from snakes. The animals aid farmers by preying on such pests as mice and rats. In some countries, especially China, people eat the meat of snakes. The skin of boas, elephant trunk snakes, and pythons is used to make such items as belts and handbags. This use of snake skins has endangered many species of snakes. Several countries now have laws to prevent the importation of such items.

Snake venom has several uses in medicine and biological research. *Antivenin,* which is used to treat snakebite, is prepared from the blood serum of horses that have been injected with venom. Certain painkilling drugs are prepared from neurotoxins in venom. Researchers use the powerful enzymes in venom to break down complex proteins for biochemical studies.

In general, snakes are abundant in most parts of the world. But human beings have caused a decline in the numbers of some species, partly through overhunting and by needlessly killing them. People also destroy the places where snakes live by clearing land for farms, houses, and industries. Human activities threaten the survival of a few species, including the Indian python, the Jamaican boa, and the San Francisco garter snake. In the United States, laws prohibit people from buying, selling, or killing endangered species.

Albert F. Bennett

Scientific classification. Snakes belong to the order Squamata in the class Reptilia. They form the suborder Serpentes, also called Ophidia.

Related articles in *World Book* include:

Kinds of snakes

Adder
Anaconda
Asp
Boa
Boa constrictor
Bushmaster
Cobra
Copperhead
Coral snake
Fer-de-lance
Garter snake
Kingsnake
Mamba
Milk snake
Python
Racer
Rattlesnake
Viper
Water moccasin

Other related articles

Herpetology
Molting
Reptile
Snake charming
Snakebite

Outline

I. The bodies of snakes
A. Body shape
B. Scales and color
C. Skeleton
D. Muscles
E. Internal organs
F. Sense organs
G. Fangs and venom glands

II. Ways of life among snakes
A. Methods of movement
B. Reproduction
C. Regulation of body temperature

D. Feeding habits
E. Protection against enemies
F. Battles among male snakes
G. Life span

III. Classification of snakes

A. Blind snakes
B. Boids
C. Burrowing asps
D. Colubrids
E. Elapids
F. File snakes
G. The Mexican burrowing snake
H. The pipe snake
I. Primitive blind snakes
J. Pythons
K. Round Island boas
L. Shield-tailed snakes
M. Sunbeam snakes
N. Thread blind snakes
O. Vipers

IV. The importance of snakes

Questions

What kind of fangs do vipers have?
Why can snakes survive for a long period of time without food?
How do snakes swallow their prey?
What is the most common way that snakes move about?
How have human beings caused a decline in the numbers of some species of snakes?
How do most snakes raise their body temperature?
What is the Jacobson's organ? How is it used?
To what family do most species of snakes belong?
How do constrictors kill their prey?
How many species of snakes are there?

Additional resources

Badger, David. *Snakes.* Voyageur Pr., 1999.
Ernst, Carl H., and Zug, G. R. *Snakes in Question.* Smithsonian Institution, 1996.
Gaywood, Martin, and Spellerberg, I. F. *Snakes.* Voyageur Pr., 1999. Younger readers.
Montgomery, Sy. *The Snake Scientist.* Houghton, 1999. Younger readers.

Snake charming is an ancient form of entertainment in northern Africa, and in India, Pakistan, and other parts of southern Asia. A snake charmer usually uses a cobra. The charmer sits in front of the snake, playing a flute and swaying back and forth. The snake, in turn, raises its head and neck and begins to sway. The snake responds to the movements of the charmer, rather than to the music, which it cannot hear.

Snake charmers must understand the behavior of snakes. Sometimes they cut out the fangs of poisonous snakes. This procedure makes the snakes harmless until the fangs grow back in. Some circuses employ people called "charmers" who handle harmless boa constrictors or pythons. Albert F. Bennett

Snake dance is a sacred ceremony of the Hopi Indians of northeastern Arizona. The ceremony is held each August and lasts nine days. During the first four days, the men of a Hopi group called the Snake Society hunt rattlesnakes. On the afternoon of the ninth day, the men, who are expert at handling rattlesnakes, dance with the live snakes in their mouths. After the dance, they release the snakes. The dance is part of an annual cycle of Hopi ceremonies. Through these ceremonies, the Hopi appeal to supernatural powers for rain, good harvests, good health, and peace. Michael D. Green

Snake killer. See Roadrunner.

Snake River is the chief branch of the Columbia River. The Snake River rises in Wyoming near the Continental Divide in Yellowstone National Park. The river then flows south through Grand Teton National Park. It bends west and flows across the Snake River Plains of southern Idaho (see **Idaho** [physical map]). Irrigation projects, dams, and falls provide water for power and irrigation for the cities and farms located on the plains.

The Snake River turns north at the Oregon border. The river forms part of the boundary between Idaho and Oregon and flows through Hells Canyon. At Lewiston, Idaho, it turns west and flows through southeastern Washington. Boats can use the Columbia and Snake rivers from the Pacific Ocean inland to Lewiston. Lewiston and nearby Clarkston, Washington, are important ports for grain and wood products exports. The Snake River joins the Columbia River near Pasco, Washington, 1,038 miles (1,670 kilometers) from its source. Harley Johansen

See also **Idaho** (Rivers; picture).

Snakebird. See Anhinga; Wryneck.

Snakebite is the wound made by the fangs of a poisonous snake or the teeth of a nonpoisonous one. Snakes usually only bite to capture prey for food. But a snake will sometimes bite to defend itself when it feels threatened. If a poisonous snake bites a human being, the victim must receive immediate medical treatment. But if the snake was nonpoisonous, the bite need only be washed thoroughly with soap and water.

The appearance of the bite can help determine whether or not the snake was poisonous. A poisonous snake injects venom into its victim's body through hollow fangs. These fangs will cause one or more puncture wounds in the skin. Most nonpoisonous snakes do not have fangs. Their bites leave a series of superficial wounds, often in the shape of a horseshoe.

Types of poisonous snakes. There are two major types of poisonous snakes: (1) *vipers* and (2) *elapids.* Vipers include rattlesnakes, copperheads, and water moccasins. Many vipers strike and release their victims quickly because their fangs can shoot venom instantly into the wound. The area around the bite stings severely, swells quickly, and turns purple. The victim may then become pale, weak, and nauseated. The victim's pulse becomes weak and rapid.

Elapids include cobras, mambas, and coral snakes. The fangs of an elapid snake do not deliver venom quickly. Therefore, an elapid frequently hangs on to its victim and chews, forcing venom into the bite. In most cases, the wound from an elapid bite causes little pain at first. But later, the breathing organs of the victim become partly paralyzed, and the victim becomes sleepy. See **Snake** (Fangs and venom glands; Protection against enemies; Vipers; Elapids).

First aid. The following first aid procedures apply mainly to bites of poisonous North American snakes. In other parts of the world, people bitten by poisonous snakes should contact medical authorities for appropriate treatment procedures.

If a snakebite occurs, immediately call an ambulance or a local poison control center. If possible, identify the type of snake that made the bite. Position the victim's body so that he or she is comfortable and can lie still. Try to keep the victim calm because activity can speed the spread of the venom.

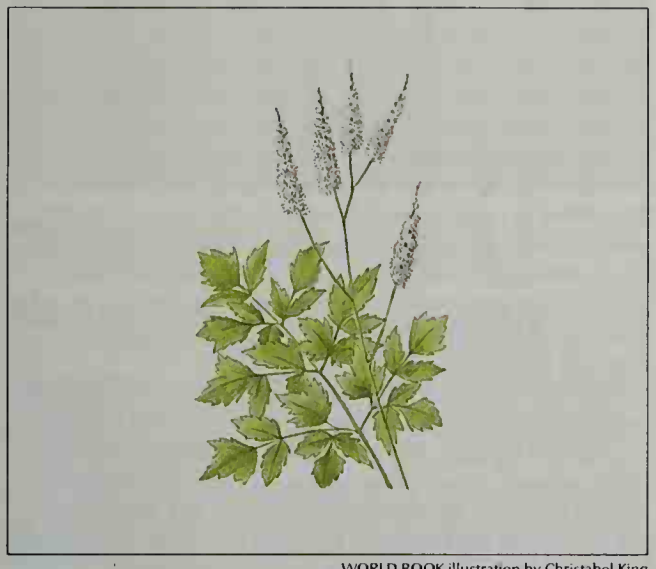
If medical assistance will be delayed, tie a band of cloth above the bite. The band must fit snugly but should be loose enough for someone to slip a finger underneath it. Do not loosen the band until medical care is obtained. The victim may drink water unless nausea develops. Do not give the victim any form of alcohol to drink, and do not give aspirin, any drug containing

aspirin, or any aspirin substitute containing acetaminophen or ibuprofen. Do not give snakebite serum or attempt to cut the skin surrounding the bite without a physician's advice.

Critically reviewed by the American Red Cross

Snakeroot is the name of several very different flowering plants that grow in prairies and woodlands. These plants all became known as snakeroot because their roots supposedly looked like snakes or because they were used to treat snakebites.

Virginia snakeroot grows in the Eastern United States.



WORLD BOOK illustration by Christabel King

The common black snakeroot produces a medicinal drug.

It reaches a height of up to 3 feet (91 centimeters) and has brownish-purple flowers. People once chewed its roots and then applied them to wounds. *Texas snakeroot,* also called *Red River snakeroot* and *serpentary,* is found in Arkansas, Louisiana, and Texas. It has bright-green oval leaves and dark-brown flowers. Texas snakeroot was used to make a tonic taken as a stimulant and painkiller. *Button snakeroot* grows in the Eastern and Central United States. American Indians used it for rattlesnake bites. Button snakeroot has long narrow leaves and purple flowers.

A number of plants are called *black snakeroot.* Perhaps the most common of these is a tall herb also known as *bugbane* and *black cohosh.* This plant grows up to 8 feet (2.4 meters) tall and is found in woods and on shady hillsides in the eastern half of the United States and Canada. Its roots produce a bitter medicine that has been used to treat breathing ailments. Margaret R. Bolick

Scientific classification. Virginia and Texas snakeroot belong to the birthwort family, Aristolochiaceae. Virginia snakeroot is *Aristolochia serpentaria* and Texas snakeroot is *A. reticulata.* Button snakeroots are in the genus *Liatrus* of the composite family, Compositae. The common black snakeroot belongs to the crowfoot family, Ranunculaceae. It is *Cimicifuga racemosa.*

Snapdragon is a group of hardy plants with colorful flowers. Each flower has two lips that open like jaws when the sides of the flower are pressed. Honey bees can force open the lips to obtain nectar. When the pressure is released, the lips snap shut.

The *common snapdragon* is native to the Mediterranean region and is a popular garden plant. The velvety flowers are 1 $\frac{1}{2}$ to 2 inches (3.8 to 5.1 centimeters) long and may be a variety of colors. The plant grows 2 to 3 feet (60 to 90 centimeters) tall, but dwarf varieties are smaller. The common snapdragon thrives in full sun. Smaller-flowered species of snapdragons are native to the Pacific coast of North America.

Donna M. Eggers Ware

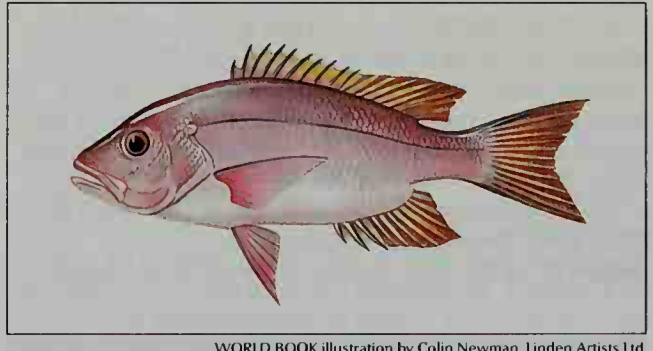
Scientific classification. Snapdragons belong to the figwort family, Scrophulariaceae. They make up the genus *Antirrhinum.* The common snapdragon is *A. majus.*

WORLD BOOK illustration by Lorraine Epstein

Snapdragon

See also **Flower** (picture: Garden annuals).

Snapper is any of about 185 species of food fishes that live in tropical parts of the Pacific and Atlantic oceans. The snappers of the Western Hemisphere are most common around Florida, the West Indies and the shores of the Gulf of Mexico, and the Caribbean region. In the Pacific, they live chiefly around the tropical coral atolls and the East Indies and Philippines. They live rather close to shore, usually in rocky places.



WORLD BOOK illustration by Colin Newman, Linden Artists Ltd.

The northern red snapper, *shown here,* is common in the Gulf of Mexico. Snappers live in warm ocean waters.

Snappers grow 2 to 3 feet (60 to 90 centimeters) long. They have a high, almost humped, back and are rather flat from side to side. The mouth is large, with strong teeth. The tail is slightly forked. Snappers may be red, greenish, or striped. They often have a black spot on each side of the body. Some snappers, especially the larger species, may become toxic. Eating them can cause a sometimes fatal disease called *ciguatera.*

William J. Richards

Scientific classification. Snappers make up the snapper family, Lutjanidae. The northern red snapper is *Lutjanus campechanus.*

Snead, Sam (1912-2002), won more tournaments than any other American golfer. From 1936 to 1965, Snead won a record 84 tournaments sanctioned by the Professional Golfers' Association (PGA). Snead claimed a to-

tal of 165 tournament victories. Snead became known as "Slammin' Sammy" because of his powerful drives and naturally smooth swing.

Wide World

Sam Snead

Snead won the PGA title in 1942, 1949, and 1951 and the Masters Tournament in 1949, 1952, and 1954. He won the British Open in 1946. Snead finished second in the United States Open four times. In 1965, he won the Greensboro Open, becoming the oldest man ever to win a regular PGA tournament.

Samuel Jackson Snead was born on May 27, 1912, in Ashwood, Virginia, near Hot Springs. He turned professional in 1934 and won his first important tournament, the Oakland Open, in 1937. In 1980, he joined the PGA senior tour, limited to golfers at least 50 years of age. Snead died on May 23, 2002. Marino A. Parascenzo

Sneezing is a sudden and violent rush of air out through the nose and mouth. A person has no control over sneezing. The body takes this action to get rid of irritating objects in the nose. Nerve endings that line the nose react to these objects by causing the sneeze.

Sneezing occurs often in an ailment called *hay fever.* Plant pollen lodges in the nose and causes the sneeze. In addition, sunlight can cause sneezing because eye nerves are closely connected with nerve endings in the nose.

Sneezing aids the body, but can be harmful to other people. For example, the nose fills with congestion that contains germs when a person has a cold. Sneezing helps clear the nose. But unless the sneezer covers the mouth and nose, the germs escape into the air and may infect others. Charles W. Cummings

See also Disease (Spread of infectious diseases; picture); Cold, Common; Nose; Hay fever.

Snipe is the name of a group of shore birds related to sandpipers, curlews, and plovers. The common snipe, also called *Wilson's snipe,* is about 11 inches (28 centimeters) long. It has a short tail and a long bill. It uses the flexible, sensitive tip of its bill to poke about for worms and grubs. This bird performs acrobatics in the air during the mating season. It also makes a strange "drumming" sound by flying to great heights and descending in quick swoops as air rushes through its feathers.

Charlie Ott, DPI

The snipe nests in low places on the edge of marshes. The common snipe, *shown here,* has a short tail and a long bill.

Wilson's snipe spends its summers from the northern United States to Hudson Bay and Labrador. It winters from Illinois and South Carolina southward. The snipe is more timid than most sandpipers about being seen in the open by day. It nests in low places in the ground on the edge of marshes. The female lays four olive brown or grayish drab eggs thickly spotted with chocolate color. See also **Curlew.** George L. Hunt, Jr.

Scientific classification. The snipe belongs to the family Scolopacidae. Wilson's snipe is *Capella gallinago delicata.*

Snoring is rough, noisy breathing that occurs during sleep. Snoring is common among people over the age of 40. Although mild snoring is considered harmless and only an annoyance to others, severe snoring may be associated with significant and even life-threatening medical problems.

The sound of snoring is produced by the vibration of relaxed structures of the mouth and throat. As a sleeping person inhales, the muscles of the throat may remain relaxed, causing the airway to narrow. When the airway narrows, such structures as the *soft palate* and the *uvula* (the stalk of flesh hanging from the soft palate) may vibrate and produce the sound of snoring.

People who have narrow upper airways, lengthened palates or uvulas, enlarged tonsils, weak throat muscles, or difficulty breathing through their noses are most likely to snore. Snoring often occurs when the person sleeps on the back. Substances that relax muscles during sleep, such as alcohol, sleeping pills, antihistamines, or tranquilizers, make the problem worse.

During severe snoring, less air goes into and out of the lungs, which results in decreased oxygen and increased carbon dioxide in the blood. This change in blood gas levels may cause high blood pressure or heart problems such as abnormal heart rhythms. Severe snoring may be associated with *obstructive sleep apnea,* a condition in which the air passage is repeatedly blocked during sleep (see **Sleep apnea**).

Mild snoring often may be prevented by changing the sleeping position. Severe snoring may be treated with drugs, surgery, or with a mask that supplies air under pressure to expand the airway during sleep.

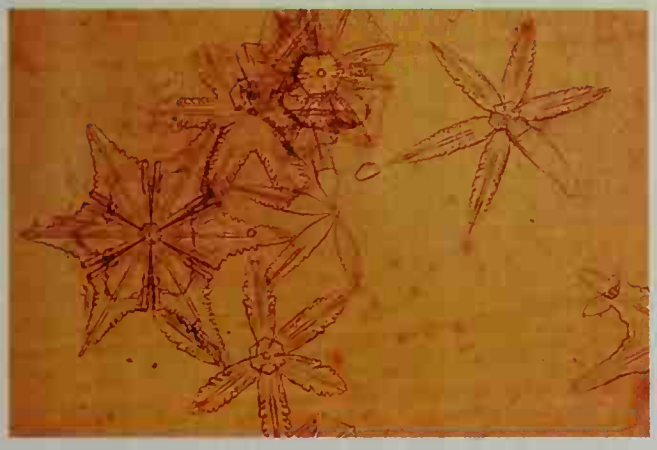
Michael G. Levitzky

Snorri Sturluson (1179-1241) was a great medieval Icelandic poet and historian. His major works were the *Heimskringla (Circle of the World),* a history of the kings of Norway from their origins up to his own day, and the *Prose Edda.* He probably also wrote *The Saga of Egill Skallagrimsson,* one of the best Icelandic sagas about a great poet of the 900's who was one of Snorri's forefathers. Snorri was a wealthy and powerful man in Iceland. In his later years, he became involved in a power struggle in Norway that led to his murder on the orders of the Norwegian king. Richard N. Ringler

See also **Edda.**

Basic snow crystal shapes All snow crystals have six sides and grow in either platelike or columnar patterns, depending on the air temperature and the amount of moisture present. These photos were taken through filters that make the snow show up against an orange background.

Brooks Martner, University of Wyoming



Platelike snow crystals appear as flat, six-sided plates. In cold, humid air, they grow in the shape of six-pointed stars.

Columnar snow crystals resemble long needles of ice. However, high humidity may cause them to become hollow columns.

Snow is a form of precipitation that consists of crystals of ice. These crystals, called *snow crystals,* grow from water vapor in clouds. Water vapor is the gaseous form of water—the form that water assumes when it evaporates. A snowflake consists of up to 100 snow crystals clumped together.

Particles of snow vary in size from crystals almost too small to see with the unaided eye to snowflakes 1 inch (2.5 centimeters) or more in diameter. Some of the tiniest crystals occur in *ice-fog,* a fog that can form in the Arctic regions when the temperature is extremely low.

Amounts of snowfall. Snowfall varies greatly across the earth. Snow falls in the polar regions throughout the year. But the heaviest snows occur during the winter in mountainous areas of the temperate zones—between the Tropic of Cancer and the Arctic Circle and between the Tropic of Capricorn and the Antarctic Circle. These areas include the western coastal ranges of North and South America and the Alps in Europe.

In the United States, the record for snowfall in one year was set from July 1971 to June 1972, when 1,122 inches (2,850 centimeters) of snow fell at Rainier Paradise Ranger Station in Washington. In 1921, a 76-inch (193-centimeter) snowfall in Silver Lake, Colorado, set a record for the largest snowfall during a 24-hour period.

A typical layer of snow on the ground would melt to form a layer of liquid water about $\frac{1}{10}$ as thick as the snow. But 1 inch of water may be equivalent to as much as 30 inches (76 centimeters) of dry, fluffy snow. Snow is a major source of water in many places. Mountain snowmelt, for example, feeds many rivers and streams.

How snow forms. Snow crystals usually start from tiny droplets of *supercooled water.* Water droplets do not always freeze at the normal freezing temperature of water, 32 °F (0 °C). Droplets of supercooled water remain liquid even though their temperature is below the freezing point.

At the beginning of the process of snow formation, some supercooled droplets freeze. They do so because they contain, or come into contact with, tiny particles called *freezing nuclei* or *ice nuclei.* Most freezing nuclei are dust or specks of plant debris raised by the wind.

Nearby, water droplets, which are still supercooled, slowly evaporate. Much of the resulting vapor joins the crystals, and so the crystals grow.

The crystals fall faster and faster as they grow. They may collide with one another to make snowflakes. Snow particles fall at rates ranging from nearly zero for tiny crystals to about 3 feet (90 centimeters) per second for a typical snowflake and several times that for melting snow. Snow crystals often strike supercooled droplets, which immediately freeze onto them. This process, called *riming,* forms soft particles known as *snow pellets* or *graupel.* In temperate zones, the melting of snow pellets provides much of the rainfall from cumulus clouds.

Nearly all snow crystals have six sides, but they vary in shape. The crystals are six-sided because the water molecules within them link together in six-sided structures. *Planar* (flat) crystals called *plates* range from simple hexagons to six-pointed stars to the familiar finely branched *dendrites.* Dendrites form at a temperature of about 5 °F (−15 °C); six-sided columns, at about 14 °F (−10 °C). Many columnar crystals are hollow.

Individual snowfalls usually contain many different types and combinations of crystals. Snow crystals that encounter a variety of temperatures and humidities as they grow may become partly planar and partly columnar. They may or may not undergo riming or clumping.

Artificial snow produced at ski resorts is actually partly frozen droplets of water. Machines make this "snow" by spraying a mixture of water and freezing nuclei into the air. Charles Knight

Related articles in *World Book* include:

Glacier	Rain	Snow line
Hail	Sleet	Storm

Snow, C. P. (1905-1980), was an Englishman of many talents who was most famous as a novelist. He was also a scientist, government official, and lecturer.

Snow's 11-volume series of novels, *Strangers and Brothers* (1940-1970), is a study of England's professional and scientific classes. Lewis Eliot is an important character and the narrator in all the novels. Like Snow, Eliot is a man of lower-class birth who works his way into profes-

sional life. Eliot appears in many jobs in the series, a device that allows Snow to present a panoramic view of English life. Eliot is a lawyer in *Strangers and Brothers* (1940) and *Time of Hope* (1949), a university teacher in *The Light and the Dark* (1947) and *The Masters* (1951), and a government official in *The New Men* (1954). In *The Sleep of Reason* (1968), Eliot serves as an observer at a murder trial. Colorless and almost stodgy, Eliot is nevertheless an impartial, selfless person. To Snow, he is the kind of individual needed to make responsible decisions.

Charles Percy Snow was born in Leicester and earned a doctor's degree in physics from Cambridge University. As a civil service commissioner from 1945 to 1960, he selected scientists for government projects. Snow was knighted in 1957. He served as parliamentary secretary to the minister of technology from 1964 to 1966. In *The Two Cultures and the Scientific Revolution* (1960), a published lecture, Snow deplored the lack of communication and of understanding between scientists and nonscientists. In *The Realists* (1978), Snow discussed the life and work of eight important European novelists.

Michael Seidel

Snow blindness is a temporary decrease in vision caused by bright sunlight reflected from snow. It may last from several days to a week. Occasionally, a person has trouble distinguishing between colors after snow blindness and sees everything colored red. In most cases, snow blindness disappears when a person rests the eyes and remains indoors. However, in rare cases, prolonged exposure to the reflected light can lead to *solar retinopathy,* a disorder that may result in some permanent loss of vision. Wearing sunglasses or dark-colored goggles helps prevent snow blindness. Ronald Klein

Snow bunting, also called *snowflake,* is a sparrowlike bird of the Far North. It is mostly white on its head and breast, but its back, wings, and tail are partially black. During the fall and winter, the bird's head and back feathers are edged with brown. These edges wear off as the winter passes. Snow buntings nest in Arctic regions during the summer, and they migrate to warmer areas to spend the winter. They are familiar winter birds in Canada. Snow buntings come as far south as the United States only when the snow is heavy.

Sandra L. Vehrencamp

Scientific classification. The snow bunting belongs to the finch family, Fringillidae. It is classified as *Plectrophenax nivalis.*

Bruce Coleman Inc.

The snow bunting has a snowy white head and breast.

Tom McHugh, Photo Researchers

The snow leopard has pale hair with brown spots.

Snow leopard, also called *ounce,* is a member of the cat family that lives in cold regions of central Asia. It spends summers in the Tibetan Highlands as high as 18,000 feet (5,500 meters) above sea level. During the coldest winter months, the snow leopard may travel down into valleys about 6,000 feet (1,800 meters) above sea level.

The snow leopard grows about 6 to 6 $\frac{2}{3}$ feet (1.8 to 2 meters) long. It has thick, pale gray hair marked with leopardlike brown spots. When hunting, a snow leopard quietly stalks its prey and then springs on it. Snow leopards have been observed leaping as far as 45 feet (15 meters). The snow leopard eats such wild mammals as deer, ibex, marmots, and picas, as well as domestic livestock.

Although the snow leopard resembles such big cats as lions and tigers in size and appearance, it has many characteristics of smaller cats. For example, the snow leopard cannot roar like other big cats, but it can purr like a domestic cat. Also, snow leopards feed in a crouched position, as do domestic cats. Other big cats feed while lying down.

Snow leopards are mostly solitary animals. However, males and females hunt together during the mating season. Female snow leopards give birth in the spring or early summer, usually to two or three cubs. The snow leopard is an endangered species because so many have been killed for their fur. C. Richard Taylor

Scientific classification. The snow leopard belongs to the cat family, Felidae. Its scientific name is *Panthera uncia.*

See also **Animal** (picture: Animals of the mountains).

Snow line is the lower edge of the permanent snow fields found on upper mountain slopes. The location of the snow line depends upon the height of the sun, latitude, winds, temperature, and moisture. The snow line on the same mountain range may change from year to year. In the tropics, the snow line is about 3 miles (4.8 kilometers) above sea level, and in the subtropics it is about 4 miles (6.4 kilometers) above sea level. The snow line of the Rocky Mountains of the United States is about 2 miles (3.2 kilometers) above sea level. In the Alps of Western Europe, it is about 1 $\frac{1}{4}$ miles (2 kilometers) above sea level. It is less than $\frac{1}{2}$ mile (0.8 kilometer) above sea level in Greenland. It is at sea level in polar lands. William C. Mahaney

Snowball, also called *European cranberry bush* or *Guelder rose, GEHL duhr ROHZ,* is a handsome shrub of

E. R. Degginger

The snowball shrub was named for its showy flowers.

the honeysuckle family. It produces large, ball-shaped white flowers that grow in clusters. The plant is believed to be native to the Dutch province of Gelderland. Today, it is often grown in parks and lawns in the United States. It is a cultivated form of highbush cranberry and grows from 7 to 12 feet (2.1 to 3.7 meters) tall. The flowers of the cultivated species are sterile and do not produce fruit. However, a wild variety of the plant bears juicy, red berries. Fred T. Davies, Jr.

Scientific classification. The snowball is in the honeysuckle family, Caprifoliaceae. It is *Viburnum opulus*.

Snowboarding is a popular winter sport that resembles surfing or skateboarding on snow. A snowboarder is strapped onto a single board that looks like a large skateboard and glides down snow-covered mountains. Snowboarders perform many of the same movements as Alpine and freestyle skiers. See **Skiing** (Types of skiing).

A snowboard is a single board 2 $\frac{1}{2}$ times as wide as a ski and about $\frac{2}{3}$ as long. Snowboarders most commonly wear footwear that resembles hiking boots.

Snowboarding technically is not skiing, but it is performed on Alpine ski mountains. Top-level snowboarders compete in slalom and giant slalom races similar to those in Alpine skiing, as well as an acrobatic event called a *half-pipe* performed in a deep trough. Snowboarding follows women's skiing rules for both men's and women's slalom and giant slalom events. Competitions are supervised by the governing body of international amateur skiing, the Fédération Internationale de Ski (FIS). In 1998, snowboarding became an event in the Winter Olympic Games.

© Shaun Botterill, Allsport

Snowboarding is a popular winter sport in which a snowboarder is strapped to a board and glides down snowy slopes. Snowboarders perform many of the same movements as skiers.

Snowboarding first became popular during the 1980's among young people as an alternative to skiing. Most ski resorts at first rejected snowboarding as disruptive to traditional skiing, but now almost all resorts welcome snowboarders. Steve Cohen

Snowdrop is the name of a group of flowering plants native to Europe, the Middle East, and western Asia. Some species, including the *common snowdrop* of Europe, are commonly grown in gardens. Snowdrops bear nodding, white, bell-shaped flowers. Snowdrops are one of the earliest spring flowers, and they sometimes flower during warm spells in midwinter. Some snowdrops bloom in the fall. The common snowdrop is sometimes called the *Fair Maid of February*.

WORLD BOOK illustration by Christabel King

Snowdrop

Snowdrops grow from a small bulb that produces two or three narrow leaves and a flower stalk. The stalk of the common snowdrop usually grows from 4 to 9 inches (10 to 23 centimeters) tall. Snowdrops are easy to cultivate, and they grow best in partial shade and moist soil. The bulbs are planted 3 to 4 inches (7.5 to 10 centimeters) deep in the fall. Snowdrop plants multiply each year, and a few bulbs may eventually produce large clumps of snowdrops. James S. Miller

Scientific classification. Snowdrops are in the amaryllis family, Amaryllidaceae. The common snowdrop is classified as *Galanthus nivalis*.

Snowflake. See Snow; Snow bunting.

Snowmobiling is a popular wintertime activity in which one or two people ride in a motorized sled over ice and snow. The sled is called a *snowmobile*. People use snowmobiles for work or recreation. Snowmobiling also is a popular winter sport in Canada, the northern United States, and the colder regions of Europe.

The first sled-sized snowmobiles built by mass production were manufactured during the late 1950's. Most snowmobiles measure from 5 to 8 feet (1.5 to 2.4 meters) long and about 3 to 4 feet (0.9 to 1.2 meters) wide. Snowmobiles ride on two short skis on the front of the vehicle, and a wide *track* (belt) toward the rear. An engine of 8 to 100 horsepower (6 to 75 kilowatts) moves the track, propelling the snowmobile. The operator steers with handlebars. Most snowmobiles can go at least 50 miles (80.5 kilometers) per hour, and some can

© Bachmann, Photo Researchers

Snowmobiling is a popular wintertime sport in which one or two people ride over ice and snow in a motorized sled called a *snowmobile*. Snowmobiles are also used for transportation.

travel more than twice that speed.

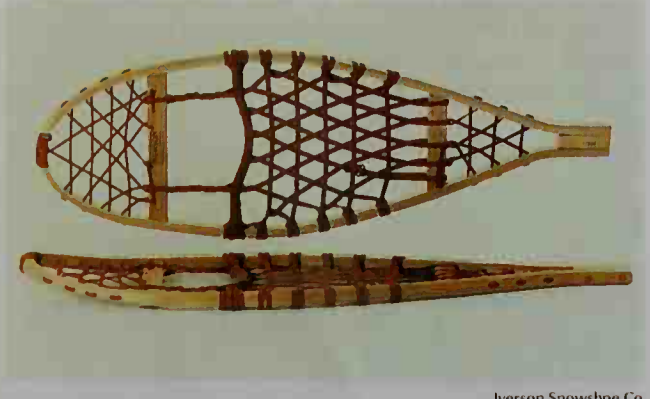
Some environmental groups criticize snowmobiling. They believe it destroys trees and other plants and endangers wildlife. They also declare that the noise of snowmobile engines disturbs the peacefulness of wild areas. To deal with these objections, a number of states and provinces restrict snowmobiling to special trails and enforce snowmobile speed limits and noise levels. In addition, snowmobile clubs vigorously promote safe and considerate driving. Joseph Skorupa

See also **Inuit** (picture: Inuit communities); **Royal Canadian Mounted Police** (picture); **Safety** (Safety in recreation).

Snowshoe is a device used for walking over snow. Snowshoes distribute a person's weight over a large area, which prevents the person from sinking into the snow. Most snowshoes are at least 3 feet (90 centimeters) long, and from 1 to 1 $\frac{1}{2}$ feet (30 to 46 centimeters) wide. They are made of a light wooden frame, bent into a long oval. Strings of animal hide are stretched across the frame. In walking with snowshoes, the wearer moves the feet so that the snowshoes slide along the surface of the snow. The wearer gives an outward motion to the snowshoes with each step.

North American Indians were among the first people to use snowshoes. Today, snowshoes are used in regions of deep snow by hunters, trappers, loggers, and farmers. Skiers, hikers, and other sports enthusiasts also use snowshoes to reach remote recreational areas. Robert C. Post

See also **Indian, American** (picture: Snowshoes).



Iverson Snowshoe Co.

Snowshoes look like oddly shaped tennis rackets. They are made of strings of animal hide stretched over a wood frame.

Snowshoe hare is a medium-sized hare that lives in North America. It is also called *varying hare*. Snowshoe hares live in forests and swamps of Canada and the northern United States, including Alaska. They also are found in mountains as far south as New Mexico in the west and Tennessee in the east. Snowshoe hares have large, hairy hind feet for hopping over snow.

Adults measure up to about 20 inches (50 centimeters) long. Most weigh about 3 pounds (1.3 kilograms). For most of the year, the animal has a brown upper coat and a whitish chin, belly, and tail. In winter, the animal sheds its coat and grows a new one. This coat is all white except for black on the tips of the animal's long ears.

Snowshoe hares are active mainly at night. They feed on a variety of plant life, including grasses and leaves. In some areas, deep snow during winter allows them to feed on the leaves of such trees as spruces and pines. Female snowshoe hares give birth as many as four times a year. Two to four young may be born each time.

© Mary Stouffer, Animals Animals

The snowshoe hare has a brown coat during most of the year. In winter, it sheds this coat and grows a white one, shown here.

Many animals prey on snowshoe hares. Their chief enemies include snowy owls and lynx. In addition, people kill hundreds of thousands of snowshoe hares each year for food and sport. Charles A. Long

Scientific classification. The snowshoe hare belongs to the order Lagomorpha in the rabbit and hare family, Leporidae. It is *Lepus americanus*.

See also **Hare**.

Snuff is a moist or dry powder made from the leaves of the tobacco plant. The tobacco is first fermented by heat and moisture and then dried and ground. Moist snuff is placed between the cheek and gum. Dry snuff may be sniffed in through the nostrils, rubbed on the gums, or *dipped*—that is, placed in the mouth, usually between the gum and lower lip. Various flavorings are added to snuff to improve its taste. Taking snuff can irritate the nerves that carry the sensation of smell and lessen the ability to distinguish odors. Many physicians believe that the use of snuff increases the risk of developing cancer of the mouth and other gum diseases. J. H. Smiley

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